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15 April 1921--24 January 2007

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For 2003

Volume 36

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Organized by Jeff Goddard
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Using trace element concentrations in mytilid mussel shells to determine larval sources

B. J. Becker[1], L. Levin[2], P. Mcmillan[2], and F. J. Fodrie[2]

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Elemental fingerprinting utilizes a tag naturally found in the environment, such as trace elements or temperature and salinity signals, to track movements of animals. The chemical composition of newly formed calcium carbonate structures strongly reflects many aspects of the seawater environment in which it is precipitated. If the conditions are sufficiently different at nearby locations and hard parts are retained after settlement, it is possible to determine from where new mollusk settlers came by analyzing the chemical composition of the larval shells they formed earlier in their lives. We are developing a technique to analyze the chemical composition of mussel (*Mytilus galloprovincialis* and *M. californianus)* shells collected in San Diego County, California (USA) for larval tracking purposes. We are able to analyze the solid shell directly using laser ablation and a high-resolution ICP-MS, in order to determine composition on a small scale (20-40 microns). We are therefore able to study multiple elemental fingerprints on the same shell, representing various periods in the development of the individual. In order to verify the validity of the method, we first must determine if signals are significantly different on an appropriate spatial scale to differentiate between larvae from different sites. In addition, the temporal variability of this signal must be defined. We analyzed samples from multiple sites (at the same time) and from multiple times (at the same site) in order to determine the spatial variability and temporal stability of the signal. The next step is to use this method to determine larval sources. Long-term goals include determination of degree of self-seeding in a local marine reserve and the amount of exchange between bays and the open coast populations.

Diet-specificity in sponge-feeding nudibranchs from Cape Arago, Oregon

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Eudoridacean nudibranchs are specialized predators of sponges in marine benthic communities. Few studies have examined prey use in local assemblages of dorids, and little is known about how their diets and host-use vary geographically and by habitat. I studied diet specialization and overlap in eudoridaceans (excluding *Rostanga pulchra*, a small dorid which

preys exclusively on encrusting red-orange sponges) in intertidal cobble fields on the protected outer coast at Cape Arago, Oregon. I determined diets by direct observation of feeding in the field and by microscopic examination of sponge spicules in the fecal strands or gut contents of specimens isolated at collection. To determine dietary overlap I calculated coefficients of similarity using the Bray-Curtis Index and the frequency of each dorid species feeding on each sponge. To compare the observed diets with prey preferences, I conducted pair-wise chemosensory experiments using a chamber with directional, turbulent mixing in the main test arena of the two source flows.

I obtained 515 prey records for nine species of dorids. *Hallaxa chani*, *Aldisa sanguinea* and *Geitodoris heathi* were the most specialized and consumed only one species each (*Halisarca* sp., *Hymedesmia* sp. and *Mycale macginitei*, respectively), while *Cadlina luteomarginata* and *Diaulula nobilis* were the most generalized and consumed 12 and 17 species, respectively. The results of the chemosensory experiments generally matched the observed diets, with the conspicuous exception of the significant preference of *Archidoris odhneri* for *Halichondria panicea* over *Hymeniacidon ungodon*, the sponge on which it was usually found feeding in the field. Diet overlap between species ranged from 0 to 49%, with a mean of 6%. It was greatest between *Cadlina modesta* and *C. luteomarginata* (49%) and *C. luteomarginata and Diaulula nobilis* (28%). Bloom (1981) reported a mean dietary overlap of 46% for six species of eudoridaceans in the San Juan Archipelago. Mean diet overlap for the same six species at Cape Arago was 7%. With the exception of *Geitodoris heathi*, which preyed on a single species at Cape Arago and was reported by Bloom (1981) to consume eight species in the San Juans, dietary specialization (measured as both species richness and diversity of prey) was similar for each of these species at both sites. Reduced dietary overlap at Cape Arago likely reflects the higher species richness of sponges on the outer coast at Cape Arago, compared to the inland waterways of the San Juan Archipelago.

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Restored marshes with tidal pools in San Francisco Estuary yield common, ancient gastropods, other aquatic invertebrates, and their predatory fishes

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We have extensively compared populations of aquatic animals in seven restored and historical brackish marshes around southern Suisun Bay of San Francisco Estuary. Kayaks provided access to narrow tidal creeks and shallow-water marshes largely isolated from previous research. Non-destructive seasonal sampling included ~four replicate refugia traps (modified mesh minnow traps,) each representing a total area of 1 m^2, near vegetation. Common aquatic animals

including amphipods, isopods, and gastropods, and fishes as predators, were abundant in several restored marshes compared with reference marshes. Only sites with marsh tidal ponds yielded numerous aquatic animals. Those restored brackish marshes yielded the most abundant fish populations, and unusual, thriving hydrobiid snails 5 mm long, a close relative of California's endangered brackish water snail. The unusual snail apparently is *Hydrobia andersoni*, previously known only from fossils on this ancient San Joaquin River. Sediment cores in the marsh repeatedly yielded these shells over 130 cm deep. Slow sedimentation rates in these isolated marshes suggest a probable age of >~200 years for shells at this depth, indicating that these snails are natives. Subsequent mini-quadrat sampling at the older restoration site yielded high densities of snails, ~200 per 25 cm^2 in the mud's surface and ~60 per 25 cm^2 on *Ruppia* widgeongrass and *Enteromorpha* green algae. Marsh tidal pools connected to tidal creeks seem very important in restoring ancient populations of estuarine predators and prey animals, possibly overlooked previously in these isolated marsh habitats, previously too difficult to reach and difficult to sample properly.

Cryptic impacts of invasive species: Parasites of sympatric native and introduced snails

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Species introduced to new environments without the parasites that infect them in their native range may experience a performance advantage relative to both conspecifics in the native range, and to more heavily parasitized native competitors. Additionally, introduced species that bring parasites with them may exert unforeseen, broader impacts on native ecosystems. We assessed the role of parasites in a marine invasion by first examining regional patterns of trematode parasitism in the introduced Japanese mud snail, *Batillaria attramentaria* (= *B. cumingii*), throughout nearly all of its introduced range in North America. We recovered only one parasite species, which was itself a non-native species, *Cercaria batillariae*. The prevalence of this introduced trematode in its snail host was highly variable, ranging from 3 to 86%. To determine if parasites were potentially important in mediating the invasive snail's competitive displacement of a native sympatric mud snail, *Cerithidea californica*, in Bolinas Lagoon, California we quantified diversity and prevalence of parasites in both snail hosts. Prevalence of larval trematodes infecting snails as first intermediate hosts was not significantly different (14% in *B. attramentaria* versus 15% in *C. californica*). However, while the exotic snails were parasitized only by one introduced trematode species, the native snails were parasitized by ten native trematode species. Furthermore, only the native *C. californica* was infected as a second intermediate host, by *Acanthoparyphium spinulosum* (78% prevalence). Given the high host specificity of trematodes for first intermediate hosts, in marshes where *B. attramentaria* is competitively excluding *C. californica*, 10 or more native trematodes will also become locally

extinct. Because of the obligate multi-host life cycle of these trematode species, their loss will likely affect life histories, population dynamics, and fitness of several native estuarine species.

Japanese sacoglossan opisthobranchs associated with *Codium* spp. (Chlorophyta)

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Diverse and abundant populations of sacoglossan opisthobranchs inhabit Japanese rocky shores. The species of sacoglossans that feed on the green macroalgae *Codium* spp. were investigated in Sagami Bay on the Pacific coast of Honshu, Japan. On the Miura Peninsula (eastern side of Sagami Bay), three sacoglossan species were particularly abundant: *Elysia trisinuata* Baba, 1949, *E. setoensis* Hamatani, 1968, and *Placida* sp. Baba, 1986. Phenology, population dynamics, and algal host use of these species are described based on numerous short-term visits to Misaki Maine Biological Station (MMBS) between 2000 and 2003 and the literature. *Elysia trisinuata* grows substantially larger than sympatric sacoglossans on *Codium* with maximum weight ca. 750 mg. This sacoglossan spawned in spring, and small juveniles appear on algal hosts in summer. Juvenile slugs fed on at least three *Codium* spp., whereas adult conspecifics are presumed to rely largely on functional kleptoplasty. The congener *E. setoensis* was quite abundant on *C. fragile* in summer but did not form feeding aggregations or cause extensive grazing damage. Finally, *Placida* sp. was small, seasonally abundant on algal hosts, and often caused visible grazing damage. These sacoglossan species frequently coexisted on algal hosts, particularly *C. fragile*. Interspecific interactions appeared to be minor with no discernible interference or exploitation competition. There was no evidence that these Japanese sacoglossans controlled the population abundance and distribution of their *Codium* hosts.

Rock and coral boring Bivalvia (Mollusca) of the Middle Florida Keys, USA

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Eight species from three bivalve families were collected and/or observed in the Middle Florida Keys. Diagnoses based on shell characters are given for *Botula fusca*, *Lithophaga antillarum*, *L. aristata*, and *L. bisulcata* in the Mytilidae, and *Gastrochaena hians* in the Gastrochaenidae. Shell and anatomical comparisons are made for three members of the

Petricolidae, *Petricola lapicida*, *Choristodon robustum*, and *Choristodon* sp. A, which is not attributable to a described Recent *Choristodon* species.

These bivalves bore into limestone and dead coral, and in one case into living coral. Observations substantiated previous hypotheses of primary chemical boring processes in *Botula* and *Petricola*.

Where does the escargot? Molluscan statoliths and protoconchs as natural tags of natal origin

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The management of commercially important marine invertebrates requires knowledge about larval dispersal pathways, yet no effective means exist to track invertebrate larvae in the plankton from source to settlement location. Mineralized hard parts (e.g., statoliths, protoconchs, carapaces, and larval skeletons) formed at the source of larval production potentially record a natural tag of a larva's origin in their elemental composition; they represent a new tool for tracking larval movements. I examine the utility of protoconchs and statoliths as markers of natal origin in the marine neogastropods *Kelletia kelletii* and *Concholepas concholepas*, and in the estuarine opisthobranch *Alderia modesta*. Data generated from controlled laboratory culturing experiments suggest larval statoliths and protoconchs meaningfully record variation in seawater physical and chemical properties. Survey data demonstrate that larval hard parts formed at geographically separated oceanic coastal sites show distinct chemical signals. Together, these data suggest larval statoliths and protoconchs can be powerful new tools for tracking dispersal pathways and identifying source populations.

II. PALEONTOLOGY SYMPOSIUM

Organized by Lindsey Groves

Natural History Museum of Los Angeles County

New species of Late Cretaceous cypraeids (Mollusca: Gastropoda) from Californina and British Columbia

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Cretaceous cypraeids are rare in North American strata and comprise 15 recognized species (Groves, 1990). Four new species will be described from localities in southern and northern

California and British Columbia. These new species include two species of *Bernaya* s.s., a single species of *Bernaya* (*Protocypraea*), and a single species of *Palaeocypraea* s.s. The new species are as follows: *Bernaya* n.sp. 1 from the Upper Cretaceous (lower Campanian), Chico Formation, Butte County, California; *Bernaya* n.sp. 2 from the Upper Cretaceous (upper Santonian/lower Campanian), Haslam Formation, Vancouver Island, British Columbia; *Bernaya* (*Protocypraea*) n.sp. from the Upper Cretaceous (lower Campanian), Chico Formation, Butte County, California; and *Palaeocypraea* s.s n.sp. from the Upper Createceous (lower Santonian/lower Campanian), Chico Formation, Butte County, California. The Campanian/Maastrichtian is the Mesozoic peak in terms of both numbers of species and geographic distribution both in North America and worldwide (Groves, 1994).

CRETACEOUS CYPRAEOIDEANS OF NORTH AMERICA

EARLY CRETACEOUS (1 species)

Albian [1 species]

Cypraeidae
*Palaeocypraea (Palaeocypraea) fontana (*Anderson, 1958): Shasta Co., California

LATE CRETACEOUS (18 species)

Turonian [3 species]

Cypraeidae
Bernaya (Protocypraea) berryessae (Anderson, 1958): Yolo Co., California
B. (P.) argonautica (Anderson, 1958): Jackson Co., Oregon

Ovulidae
Eocypraea (Eocypraea) louellae Groves, 1990: Yolo Co., California & Jackson Co., Oregon

Campanian [8 species]

Cypraeidae
Palaeocypraea (Palaeocypraea) suciensis (Whiteaves, 1895): San Juan Co., Washington
Palaeocypraea (P.) n.sp.: Chico Fm., Butte Co., California
B. (B.) burlingtonensis (Schilder, 1932): Burlington Co., New Jersey
B. (B.) n.sp. 1: Chico Fm., Butte Co. & Placer Co., California
B. (B.) n.sp. 2: Haslam Fm., Vancouver Id., British Columbia
Bernaya (Protocypraea) mississippiensis Groves, 1990: Lee Co., Mississippi
B. (P.) n.sp.: Ladd Fm., Orange Co., California

Ovulidae
Eocypraea (Eocypraea) mortoni (Gabb, 1860): Wilcox Co., Alabama

Maastrichtian [7 species]

Cypraeidae
Palaeocypraea (Palaeocypraea) corsicanana (Stephenson, 1948): Navarro Co., Texas
P. (P.) grooti (Richards & Shapiro, 1963): New Castle Co., Delaware
P. (P.) nuciformis (Stephenson, 1941): Kaufman Co., Texas
P. (P.) squyeri (Campbell, 1893): Wibaux Co., Montana
B. (Bernaya) crawfordcatei Groves, 1990: San Diego Co. & Orange Co., California
Bernaya (Protocypraea) gualalaensis (Anderson, 1958): Mendocino Co. & San Diego Co., California
B. (P.) rineyi Groves, 1990: San Diego Co., California

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A new species of Miocene *Zonaria* (Mollusca: Gastropoda: Cypraeidae) from central Chile and its biogeographic significance

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Miocene cypraeids are rare in strata of western South America and were previously represented by only three species, *Muracypraea henekeni* (Sowerby, 1850) and *Zonaria (Pseudozonaria) telembiensis* (Olsson, 1964) both from the late Miocene Angostura Formation of Ecuador, and *Muracypraea angustirima* (Spieker, 1922) from the middle Miocene, Zoroitos Formation of northwest Peru. A new species of *Zonaria* s.s. is described from the lower upper Miocene (Tortonian) Navidad Formation, north of Matanzas, Cardenal Caro Province, central Chile. This new species represents the southernmost record for a cypraeid species in the Western Hemisphere. The presence of this new cypraeid species and the associated warm-water gastropod genera *Ficus*, *Distorsio*, *Xenophora*, *Echinophoria*, and *Olivancillaria* in the Navidad Formation indicate that subtropical to tropical climatic conditions existed during the Miocene in what is now central Chile.

Paleontology and geochronology of the middle and upper Pleistocene marine record in the downtown San Diego area, San Diego County, southern California

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Introduction

Paleontological monitoring and mitigation activities promulgated by environmental concerns for preserving archaeological and paleontological resources, as required by the California Environmental Quality Act (CEQA) and to be implemented by local governmental agencies, has resulted in a greatly enhanced understanding of local stratigraphic and paleontological relationships of subsurface estuarine sedimentary units in the downtown area of the City of San Diego, San Diego County, California. The lead agency responsible for implementing

environmental mitigation measures in downtown San Diego is the Centre City Development Corporation (CCDC). The CCDC has subdivided the Centre City area into eight districts or sub areas, of which six (Cortez Hill, Little Italy, Columbia, Marina, Gaslamp Quarter, and East Village) have yielded Pleistocene marine faunas in recent building excavations that are discussed herein. Due to limitations of this study, older museum collections from the Core and Horton Plaza areas are not discussed herein.

The latest phase of building construction activity in the downtown area of San Diego began in the late 1990s and continues unabated in the early 2000s. Much of this redevelopment activity is associated with the recent construction of a new major league ballpark (Petco Park) for the San Diego Padres baseball team in the East Village area. Although paleontological monitoring activities continue throughout western San Diego County, in both the City of San Diego and in outlying cities, the focus of this discussion is limited to the results of monitoring activities in new building excavations in the downtown areas of San Diego [prior to mid-2003]. Geographically, the investigation encompassed the flat lying areas of the city southwest of Balboa Park and the Interstate 5 freeway to the margin of San Diego Bay and southeast of Laurel Street and Lindberg International Airport and northwest of the Coronado Bridge and freeway approaches.

Background and History

The first mention of Pleistocene fossils from along the waterfront of San Diego Bay, in an area that is now somewhat south of downtown San Diego, was that of Dall (1878a, b), who listed 24 species of bivalves and gastropods and described *Anomia limatula* n. sp. [=*A. peruviana* d'Orbigny, 1846] from sediments that can only be those at the foot of 26th Street at Indian Point. The Indian Point locality was also discussed by Ralph Arnold (1903: 59 ff, pl. 35, fig. a), who listed a fauna of 54 species, by Frank Stephens (1929), who listed 12 abundant species from SDSNH loc. 54, by Valentine (1961), who reported a fauna of 65 molluscan species, and by Thompson (1967). This locality is assigned to the Bay Point Formation, a name proposed by Hertlein and Grant (1939) based on exposures on the west side of Crown Point ("Bay Point") in Mission Bay, as well as additional exposures around Mission Bay, San Diego Bay, and on North Island and Coronado (*i.e.*, at Spanish Bight). In the 1950's, 1960's, and early 1970's, numerous late Pleistocene faunas were described from the San Diego coastal areas by Warren Addicott, Emery Chace, William Emerson, Phil Kern (and students), Don Thompson, and James Valentine, although none of the newly described faunas was from the downtown part of San Diego. The only older Pleistocene fauna described from the greater San Diego area was that from the Lindavista Formation (Kennedy, 1973), far inland from the downtown area.

The first modern geologic maps of the Del Mar, La Jolla, and Point Loma 7.5-minute (1:24,000 scale) quadrangles were published in 1975. In these, Kennedy (1975) assigned most of the low, flat lying coastal areas to the Bay Point Formation. Subsequently, Kern (1977) separated out and described two low marine terraces, the Nestor Terrace (of Ellis, *in* Ellis and Lee, 1919) and the Bird Rock Terrace, in the coastal areas previously mapped as the Bay Point Formation by Kennedy (1975). Paleontologists now generally assign the coastal terrace deposits to either the Nestor or Bird Rock Terrace, and assign the protected estuarine sedimentary exposures to the Bay Point Formation, although some of these assignments in the north county areas may be overextended.

Deméré (1981) and Deméré and Streiff (1982) were the first to recognize that marine faunas older than those of the Bay Point Formation existed in subsurface sediments in the downtown San Diego area, as well as in surface exposures in the northern Point Loma area (Loma Portal) and in southeast San Diego. They proposed the name "Broadway fauna" for their newly recognized assemblages, based in main part on collections recovered from a sewer line trench down Broadway near its intersection with Second Avenue (Deméré, 1981, table 1; Elder, 1982, table 2). Among the species considered diagnostic of the new "Broadway fauna" were the bivalves *Argopecten abietis abbotti, Pecten vogdesi*, and the gastropod *Turritella gonostoma.* In addition to the downtown assemblages, Deméré (1981) assigned the fauna from one of the supposed Nestor Terrace localities of Kern (1977, SDSU loc. 2530) from northern Point Loma to the "Broadway fauna." Deméré (1981) also pointed out that the purported Pliocene records of Hertlein and Grant (1972) for both *Argopecten abietis abbotti* and *Pecten vogdesi* should also be assigned to the "Broadway fauna." A similar interpretation is made herein for the "Pliocene" records of the bivalve *Megapitaria squalida.* On the basis of amino acid racemization data on *Chione*, an age of 560,000 years was assigned to the "Broadway fauna," and an age of 220,000 years was assigned to a younger downtown fauna named the "E Street fauna" (Deméré, 1981)

The only subsequent literature records of elements of the "Broadway fauna" were citations of *Euvola vogdesi, Megapitaria* sp., and *Turritella gonostoma* recovered from subbottom geotechnical borings in San Diego Bay prior to an earthquake retrofit of the Coronado Bridge (Kennedy, 1999a; Kennedy and Clarke, 2001). Fragments of large pectens were also observed, but not further identified. They may well be assignable to *Argopecten abietis abbotti* upon further examination.

Geochronology and Correlation

The Pleistocene marine terraces and correlative deposits in the San Diego area are well dated and have been utilized in a number of developmental studies of Quaternary dating techniques, such as amino acid racemization (aminostratigraphy) (*e.g.*, Wehmiller *et al.*, 1977), zoogeographic correlation (Kennedy *et al.*, 1982), and uranium-series disequilibrium. On the basis of these studies, the Bird Rock Terrace dates to about 80,000 years BP, and is correlative with substage 5a of the marine oxygen isotope ($\delta^{18}O$) record (Kern, 1977; Kennedy *et al.*, 1982; Muhs *et al.*, 1992, 1994). The older and higher Nestor Terrace dates to about 120,000 years BP, and is correlative with substage 5e of the oxygen isotope record (Ku and Kern, 1974; Kern, 1977; Kennedy *et al.*, 1982; Muhs *et al.*, 1992, 1994). The Bay Point Formation at its type locality and elsewhere generally represents depositional events, often in protected estuarine environments, that occurred contemporaneously with erosional cutting of, and deposition on, the Nestor Terrace as exposed on the outer coasts of Point Loma and La Jolla. The "E Street fauna" of downtown San Diego (Deméré and Streiff, 1982) is also here assigned to the ~ 120,000 year BP, substage 5e Bay Point Formation.

Based on the results of new excavations and resulting faunal collections (Table 2) from eight of 22 building excavation sites (Figure 1) in the greater downtown San Diego area (this study, see below), it is evident that two temporally distinct, stratigraphically separate, and taxonomically recognizable faunal assemblages are present in subsurface sediments below the upper Pleistocene Bay Point Formation. In the broad sense, these correlate with the "Broadway

fauna" of Deméré (1981) and Deméré and Streiff (1982). However, the type "Broadway fauna" (Deméré, 1981, table 1) was based on a composite collection from two stratigraphic units that are here distinguished and informally referred to as the "upper Broadway" and "lower Broadway" faunas, or faunal horizons. The "upper Broadway" is characterized locally by the abundance of *Turritella gonostoma* Valenciennes, 1832, a depauperate gastropod fauna, and a reasonably diverse bivalve fauna. The "lower Broadway" fauna locally is characterized by the pectens *Euvola vogdesi* (Arnold, 1906) and the extinct *Argopecten abietis abbotti* (Hertlein and Grant, 1972), and by the lack of the distinctive *Turritella gonostoma.* Another common bivalve, found in both the "upper" and "lower Broadway" horizons, is the venerid *Megapitaria squalida* (Sowerby, 1835). Although other Surian and Panamic species may be common in Bay Point Formation sediments, it is unclear why these species are typically absent locally, except as reworked elements (*cf.* Table 1). *Euvola, Megapitaria*, and *Turritella* are all present farther north in the temporally equivalent substage 5e, ~120,000 year BP, Palos Verdes Sand of the Upper Newport Bay area in Orange County (Kanakoff and Emerson, 1959; Grant *et al.*, 1999).

The separation of the composite "Broadway fauna" into two discrete, taxonomically distinguishable assemblages is based on careful collecting procedures, detailed geologic observations, and recognition of the uniqueness of the association, or lack thereof, of certain locally biostratigraphically characteristic species (*e.g.*, *Turritella gonostoma* in the "upper Broadway" faunas, and lack of *Turritella* and dual presence of the scallops *Euvola vogdesi* and the extinct *Argopecten abietis abbotti* in the "lower Broadway" faunas, although all are also known as reworked elements in stratigraphically younger deposits (*cf.* Tables 1 and 2).

Unequivocal evidence of biostratigraphic separation of the upper and lower faunal horizons is in the formational sediments themselves. Excavation for the P1 Parking structure [now Padres' Parkade] in the East Village area between Tenth and Eleventh Avenues and between Island Avenue and J Street exposed about 20 feet of vertical section. A well preserved "upper Broadway" fauna dominated by *Turritella gonostoma* was present at the 30 foot elevation level. This unit unconformably overlay a paleosol (buried soil horizon) developed upon a second marine unit carrying a "lower Broadway" fauna (at 23 feet elevation) with specimens, some paired, of both *Euvola vogdesi* and *Argopecten abietis abbotti.* The significance of the paleosol between the two marine units is that it is indicative of an appreciable period of subaerial exposure (and soil development) prior to a subsequent marine inundation associated with the "upper Broadway" fauna. A similar stratigraphic juxtaposition was noted during excavations accompanying the Horton Plaza redevelopment project in the early 1980s (SDSNH locs. 3171-A, 3171-B).

Pleistocene marine terrace faunas and coeval estuarine faunas can be assigned ages based on our knowledge of paleoclimatic conditions that existed during previous interglacial sea level highstands of the last half million years, as interpreted from the marine oxygen isotope ($\delta^{18}O$) record. The oxygen isotope record can be interpreted several ways, including as proxy curves for both sea level (or glacial-ice volume) and paleoclimate (temperature). Whereas the local late Pleistocene faunas have been directly dated by a variety of methods, we must use the marine oxygen isotope curve as a proxy both for the height of sea level and for the degree of paleoclimatic warming of the oceans for earlier, middle Pleistocene faunas.

During substage 5a (~80,000 years BP), sea level was probably 5 to 7 meters below that of modern levels, and paleoclimatic conditions were somewhat cooler. Outer-coast marine terrace

faunas (*e.g.*, those from the Bird Rock Terrace) typically contain a distinct cool-water element, and between 10% and 20% extralimital northern species in their faunas (Kennedy *et al.*, 1982, 1993; Kennedy, 1999b). Protected bay and estuarine faunas, however, typically lack cool-water species, perhaps due to greater summer insolation and seasonality during substage 5a time (*cf.* Kennedy, 1988; Berger and Loutre, 1991). Conversely, during substage 5e (~120,000 years BP), sea level was probably about 6 meters higher than modern levels, and paleoclimatic conditions were much warmer, particularly in protected bodies of water. Substage 5e estuarine faunas (*e.g.*, those from the Bay Point Formation) typically have a strong component of warm-water, extralimital southern species, but only a minor warm-water element in unprotected outer-coast exposures (*e.g.*, those on the Nestor Terrace).

The limited number of warm-water interglacial periods prior to substage 5e, as reflected in the marine oxygen isotope record, restricts the range of possibilities for assigning ages to geologically recent sea level incursions into the San Diego embayment. Based on the tropical to subtropical nature of both the "upper" and "lower Broadway" faunas, the most plausible age assignments, correlative with the warmest periods of the last half million years, would be to oxygen isotope stage 9 (~ 330,000 ± years BP) for the "upper Broadway" fauna, and oxygen isotope stage 11 (~ 405,000 ± years BP) for the "lower Broadway" fauna. Assignments to isotope stages 9 and 13 or 11 and 13 are less likely, but not entirely undefensible. If we accept isotope stages 9 and 11 as correlative with the "upper" and "lower Broadway" faunas, respectively, then formation of the intervening paleosol would correlate with subaerial exposure during isotope stage 10 (~ 350,000 ± years BP).

Although a depositional scenario for the upper and middle Pleistocene marine record in the San Diego embayment now seems well grounded, based on a variety of criteria, this level of understanding has not been extended beyond the downtown area. For example, it now appears likely that several of the Pleistocene estuarine faunas in northern San Diego County, in San Dieguito Valley (Stephens, 1929; Deméré, 1980), San Elijo Lagoon (SDSNH loc. 3241), Batiquitos Lagoon (Pasek, 1979; SDSU loc. 3220), and in Oceanside (Deméré and Riney, 2000), may have been contemporaneous with all or part of the composite "Broadway fauna" of downtown San Diego. Further investigations in these areas seem warranted.

Project Summaries

This summary of downtown San Diego construction projects is based on paleontological monitoring activities, as well as cursory geologic examinations, at more than 20 building excavation sites in the downtown area, and representing construction sites in the Cortez Hill, Little Italy, Columbia, Marina, Gaslamp Quarter, and East Village sub areas of the Centre City Redevelopment Area of downtown San Diego. San Diego Natural History Museum staff have also monitored additional building excavations, the results of which are not included in this summary. All fossils have been deposited in the Invertebrate Paleontology Section of the Natural History Museum of Los Angeles County (LACMIP) and the Paleontology Department of the San Diego Natural History Museum (SDSNH). Of the more than 20 jobsites monitored or visited [prior to mid 2003], several resulted in little to no paleontological recovery, and are not included in the following site by site summary. It should be noted also, that residential and commercial building names will change with future ownerships, but their locations as given

below should adequately identify the project sites under discussion here. The projects are discussed geographically from northwest (Little Italy neighborhood) to southeast (East Village area). The number in parentheses following the project name identifies its location on Figure 1.

Front and Beech Apartments (1).

Little Italy neighborhood [CCDC Cortez Hill sub area]. Excavation for the Front and Beech Apartments project encompassed the entire city block bounded on the north and south by Cedar and Beech Streets, and on the west and east by Front Street and First Avenue. An "upper Broadway" fauna was collected from an utility vault excavation on the northwest corner of First Avenue and Beech Street at a depth of about 11 to 12 feet below the ground surface (elevation ~ 57 to 58 feet) (LACMIP loc. 17264). The fauna consisted of 42 species, represented by 27 or more species of bivalve mollusks, perhaps seven species of gastropods, clionid sponge and spionid worm borings, two barnacles, decapod crustacean remains, a sand dollar, and sting ray and indeterminate mammal(?) remains. The fauna is assigned to the "upper Broadway" horizon on the basis of the abundance of *Turritella gonostoma.*

Acqua Vista Apartments (2).

Little Italy neighborhood. Excavation for the Acqua Vista Apartments project encompassed the entire city block bounded on the north and south by Beech and Ash Streets, and on the west and east by Columbia and State Streets. A limited late(?) Pleistocene fauna, possibly representing the Bay Point Formation, was recovered from the basal sandy pebble-gravel layer overlying the marine abrasion surface cut across a prominent middle Pleistocene paleosol unit near the southwest corner of the excavation (LACMIP loc. 17263). The limited fauna consisted of at least 16 species, represented by seven species of bivalves, five or more species of gastropods, clionid sponge borings, and one acorn barnacle. The fauna is tentatively assigned to the Bay Point Formation on the basis of a single specimen of the tropical gastropod *Eupleura muriciformis*, abundant elsewhere in the Bay Point Formation (*e.g.*, Kennedy, 1997) but not previously identified in either the "upper" or "lower Broadway" faunas (*cf.* Table 2).

Allegro Tower (3).

Little Italy neighborhood. Excavation for the Allegro Tower project encompassed the western half of the city block between Ash and Beech Streets, and fronting on the east side of Kettner Boulevard. Several fossiliferous horizons (Table 1) were encountered in this excavation. The uppermost (LACMIP loc. 17276) was associated with a basal pebbly sandy gravel unit that appears to represent a basal transgressive lag containing shells and shell fragments reworked from underlying units. The gravel might represent either a period of strong marine erosion, or possibly to the marine transgression that occurred during marine oxygen isotope ($\delta^{18}O$) substage 5a, although evidence for this conclusion is lacking. Unconformably below the gravel unit, the main fossiliferous unit consisted of lenses of broken up shells and shell hash (LACMIP locs. 17277, 17278) and a basal transgressive shell lag (LACMIP loc. 17279) that, to date, have produced more than 100 species. This is the most diverse late Pleistocene marine assemblage known from the downtown San Diego area and is assigned to the Bay Point Formation. The composite fauna is represented by 50 or more species of bivalve mollusks, 35 species of gastropods, one scaphopod, clionid sponge and polychaete worm borings, decapod crustacean

remains, five or more species of barncles, shark and sting ray teeth, an unidentified small bone, and trace fossil remains. Four additional species (three bivalves and one gastropod) are reworked from older, "Broadway" sediments. The basal shell lag at LACMIP loc. 17279 is correlative with a similar, but much smaller, fauna previously recovered from the west side of Kettner Boulevard in the San Diego National Bank building excavation (SDSNH loc. 3412).

Reworked, water-worn specimens of *Turritella gonostoma*, and the scallops *Euvola vogdesi* and the extinct *Argopecten abietis abbotti*, representative of the "upper" and "lower Broadway" faunas, respectively, are also present in the Allegro Tower collections (Table 1). A single *Argopecten* impression was recovered from an underlying middle Pleistocene silt unit in the northeast corner of the excavation (LACMIP loc. 17354).

Broadway 655 (4).

Central downtown area [CCDC Columbia sub area]. Excavation for the Broadway 655 office tower project encompassed most of the city block located on the southeast corner of Broadway and Kettner Boulevard. The only marine fossils recovered from here were from auger-boring spoils derived from sixty-foot deep borings (LACMIP loc. 17398) for a crane-support platform that was used during construction of the high-rise building. The fossils, from a seven to 10 foot stratigraphic interval (50 to 60 foot depth, and elevation of 35 to 45 feet below sea level), consisted of broken up shells that are assigned to the "lower Broadway" fauna on the basis of the scallops *Euvola vogdesi* and *Argopecten abietis abbotti.* The fauna consisted of perhaps 20 species, represented by 13 or more species of bivalve mollusks, two gastropods, clionid sponge borings, encrusting bryozoans, one acorn barnacle, a tooth from a bony fish, and a small bone. The composite "Broadway fauna" was originally described on the basis of collections made seven blocks to the east, near the intersection of Second Avenue and Broadway (Deméré, 1981; Deméré and Streiff, 1982; Elder, 1982).

Pinnacle Museum Tower (5).

Marina district. Excavation for the Pinnacle Museum Tower project encompassed the entire city block bounded on the north and south by Market Street and Island Avenue, and on the west and east by Union and Front Streets. Fossils recovered from this excavation represent both the upper and middle Pleistocene. The upper Pleistocene unit (LACMIP loc. 17285) may possibly represent the early stage 5, substage 5e, sea level highstand (correlative with the Nestor Terrace on Point Loma around La Jolla) on the basis of stratigraphic superposition and geomorphic position, although none of the few recovered species can be considered diagnostic of this sea level event. The most abundant fossils from the excavation are from the "upper Broadway" faunal horizon, based on the abundance of *Turritella gonostoma.* The composite faunas from LACMIP locs. 17286, 17287, 17288, and 17290 consisted of at least 25 species, represented by 18 species of bivalve mollusks, two gastropods, clionid sponge borings, encrusting bryozoans, one acorn barnacle, a sting ray tooth and a bony-fish otolith. Eight species, or approximately 32 percent of the "upper Broadway" fauna, have not previously been reported in the limited published literature on the fauna (*cf.* Deméré, 1981). In addition, spoils from anchor borings in the southern half of the excavation (LACMIP loc. 17289) yielded fragmented specimens of two scallops, *Euvola vogdesi* and *Argopecten abietis abbotti*, that are considered characteristic of the "lower Broadway" fauna, and are here assigned to that faunal horizon.

Trellis Fifth Avenue (6).

Gaslamp Quarter. The excavation for the Trellis Fifth Avenue apartments building encompassed the southern half of the city block bounded on the west and east by Fifth and Sixth Avenues, and fronting on the north side of K Street. Miscellaneous shells were recovered from remnant spoils from a 50 foot deep dewatering well near the northwest corner of Sixth Avenue and K Street, but from an unknown depth interval (LACMIP loc. 17399). These may represent the "lower Broadway" fauna, based on the possible presence of *Euvola vogdesi*. In the main building excavation (LACMIP loc. 17400), however, an "upper Broadway" fauna, characterized by numerous *Turritella gonostoma*, was recovered from an elevation of 19 to 23 feet below sea level, and about 9 to 14 feet below the top of the well developed middle Pleistocene paleosol that forms a distinctive stratigraphic marker unit in the East Village area. The fauna from this excavation has not yet been processed.

Parkloft Apartments (7).

East Village (Ballpark) district. The Parkloft Apartments project encompassed the northern part of the city block bounded on the west and east by Eighth and Ninth Avenues, and fronting on the south side of Island Avenue. The collections yielded a rich "upper Broadway" fauna with abundant *Turritella gonostoma*. The composite fauna (SDSNH locs. 4556 through 4559; LACMIP unprocessed) consisted of 33 species, represented by 24 species of bivalve mollusks, five species of gastropods, clionid sponge borings, a turtle barnacle, sting ray teeth and caudal spines, and an indeterminate mammal(?) bone. Nearly 40 percent of the fauna had not previously been recorded from the limited published literature on the fauna (*cf.* Deméré, 1981, table 1). The presence of *Euvola vogdesi* is here regarded as a result of reworking following scouring by the marine transgression that cut across the older middle Pleistocene sediments containing a "lower Broadway" fauna, as recovered in the building excavations for the P1 Parking structure, the Entrada Apartments and other building sites to the north and east.

Geologically, the most interesting aspect of the Parkloft excavation was the discovery of a east-southeastwardly trending paleoshoreline running across the site, extending from the northwest corner of the excavation and subsequently identified in the Diamond Terrace excavation to the southeast. The shoreline angle was at an elevation of about 15 feet, and cut into the prominent paleosol developed on sediments containing the "upper Broadway" fauna. Rounded clasts of the paleosol material were present on the abrasion platform near the old shoreline. Marine sediments associated with the sea level event responsible for cutting of the shoreline were barren of fossils, although a limited molluscan fauna identified in a geotechnical trench to the south may be related to this shoreline. The shoreline probably represents the extent of the marine incursion that occurred during marine oxygen isotope substage 5e, and is thus correlative with the ~120,000 year BP Bay Point Formation, and with the Nestor Terrace on the outer coast.

Diamond Terrace (8).

East Village (Ballpark) district. The Diamond Terrace apartments project site encompassed the northeast corner of Ninth Avenue and J Street, across Ninth Avenue directly southeast of the Parkloft project site. Only a limited "upper Broadway" fauna was recovered from the west side

of the excavation along Ninth Avenue (LACMIP loc. 17384). The fauna consisted of 18 or more species, represented by 14 or 15 species of bivalve mollusks, two gastropods, and clionid sponge and spionid worm borings. The paleoshoreline with a shoreline angle elevation of about 15 feet, first identified in the Parkloft excavaton, is also present in the Diamond Terrace excavation. The associated marine sediments, however, were barren of fossils.

P1 Parking structure (9).

East Village (Ballpark) district. The excavation for the P1 Parking structure [now Padres' Parkade] encompassed most of the city block bounded on the west and east by Tenth and Eleventh Avenues, and on the north and south by Island Avenue and J Street. The project was not originally slated for paleontological monitoring by the CCDC, but nevertheless has yielded the most important paleontological data of any of the excavations in the East Village area [prior to mid 2003]. This excavation yielded both an "upper Broadway" fauna (LACMIP loc. 17392) characterized by the abundance of *Turritella gonostoma*, as well as "lower Broadway" faunas (LACMIP locs. 17393 through 17395) characterized by the scallops *Euvola vogdesi* and the extinct *Argopecten abietis abbotti*. The two faunas are separated by a paleosol developed upon the lower marine silt unit with the "lower Broadway" faunas. The significance of the intervening paleosol is that it indicates an appreciable period of subaerial exposure (and soil development) before the marine inundation and sedimentation associated with the "upper Broadway" fauna. Materials from these localities have yet to be processed. A similar stratigraphic relationship exists between the "upper" and "lower Broadway" faunas recovered from earlier excavations for the downtown Horton Plaza redevelopment project in the early 1980s (SDSNH locs. 3171-A, 3171-B), as well as in several more recent excavations in the Gaslamp Quarter and East Village areas [Kennedy and Stewart, in preparation].

Island Village (10).

East Village district. The Island Village Apartments excavation encompassed most of the city block bounded on the west and east by Twelfth Avenue [now Park Boulevard] and Thirteenth Street, and on the north and south by Market Street and Island Avenue. The northern part of the excavation was not very deep, and yielded poorly preserved, but occasionally paired, specimens of *Chione* in a red sandstone unit overlying a basal *Anomia-Ostrea* lag. Although regarded as middle Pleistocene in age on the basis of its preservation, the limited fauna lacks any of the typical species that characterize either the "upper" or "lower Broadway" faunas.

Fault investigation trench on Market Street (11).

East Village district. A shallow fault investigation trench around the southwest corner of Market and Fourteenth Streets has yielded spoils that were derived from one of the middle Pleistocene *Anomia-Ostrea* shell lags, and from underlying sandstones with a "lower Broadway" fauna characterized by the scallop *Euvola vogdesi* and the large cockle *Laevicardium elatum*. On the east side of Fourteenth Street, between Market Street and Island Avenue, the Natural History Museum recovered a diverse "lower Broadway" fauna from their Market Square Manor project (SDSNH loc. 4729), including a number of species not represented in Table 2.

Entrada Apartments (12).

East Village district. Excavation for the Entrada Apartments project encompassed the northern part of the city block bounded on the west and east by Thirteenth and Fourteenth Streets, and fronting on the south side of Island Avenue. Fossils recovered from the Entrada excavation include a prominent *Anomia-Ostrea* shell lag (LACMIP loc. 17274) and an underlying sandstone with abundant scallops, *Euvola vogdesi* and *Argopecten abietis abbotti*, characteristic of the "lower Broadway" faunal horizon. The lower unit (LACMIP loc. 17269) yielded a fauna of 26 species, consisting of 18 species of bivalve mollusks, five or more gastropods, clionid sponge and spionid worm borings, and sting ray remains. Of the 24 identifiable taxa, nine species, or 37.5 percent of the fauna, had not previously been recorded in the limited published literature on the fauna (*cf.* Deméré, 1981, table 1). A single *Argopecten* impression was recovered from the underlying silt unit (LACMIP loc. 17275).

Summary

Pleistocene marine invertebrate faunas from the downtown areas of the City of San Diego, California, document at three marine incursions into the San Diego embayment during the last half million years. The presence of any marine faunas correlative with the latest sea level highstand of marine oxygen isotope (δ18O) substage 5a and with the ~80,000 year BP Bird Rock Terrace is equivocal. Faunas correlative with the +6 meter sea level highstand of oxygen isotope substage 5e, responsible for cutting of the Nestor Terrace about 120,000 years BP, are assigned to the Bay Point Formation. A paleoshoreline attributable to this sea-level event has been recognized in the East Village area at an elevation of about 15 feet, but the associated marine sediments were barren of fossils. The most diverse Bay Point Formation fauna from the downtown area, in the Allegro Tower excavation on Kettner Boulevard, yielded more than 100 species of marine invertebrates (Table 1). Estuarine faunas from the Bay Point Formation are characterized by the presence of extralimital southern species that today range no farther north than the outer coast of central peninsular Baja California.

Middle Pleistocene marine faunas were first recognized in the downtown area by Deméré (1981) and Deméré and Streiff (1982), who applied the name "Broadway fauna" to them. The "Broadway fauna," however, was based on a composite collection from two stratigraphic units that are here informally referred to as the "upper" and "lower Broadway" faunas (Table 2). The upper fauna, characterized by the abundance of the gastropod *Turritella gonostoma*, dates to the sea-level highstand of marine oxygen isotope stage 9 and is assigned an age of about 330,000 years BP. The "lower Broadway" fauna, characterized by two scallops, *Euvola vogdesi* and the extinct *Argopecten abietis abbotti*, dates to the sea-level highstand of marine oxygen isotope stage 11 and is assigned an age of about 400,000 years BP

Only 18 species were originally identified in the composite "Broadway fauna" from the downtown area. We recognize at least 28 species of marine invertebrates, mainly bivalve mollusks, and two vertebrates from the "lower Broadway" fauna, and at least 48 species of marine invertebrates, also mainly bivalve mollusks, and two species of vertebrates from the "upper Broadway" fauna. It should be noted, however, that many of the downtown building excavations are continuing to encounter faunas from both the "upper" and "lower Broadway" faunal horizons, and the known diversity from each continues to increase with each new project.

In that respect, the data summarized herein [to mid 2003] must be considered only as "state of the art," but not the final word on the downtown Pleistocene faunas of the San Diego area. Given the continuing development of this part of the City, our knowledge of the subsurface estuarine sediments and their faunas should continue to increase in the coming years.

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TABLE 1

Preliminary list of late Pleistocene marine fossils from the Allegro Tower excavation site on Kettner Boulevard between Ash and Beech Streets, Little Italy neighborhood, downtown San Diego, San Diego County, California (LACMIP locs. 17276, 17277, 17278 and 17279). Abbreviations: x, present; (R), reworked from older, middle Pleistocene units ("Broadway fauna"); *cf.*, compare with; f(f), fragment(s) only; indet., indeterminate; j(j), juvenile(s); *s.l.*, *sensu lato*; sp., species (unidentified); ?, identification questionable; *, recorded from a stratigraphically equivalent horizon nearby.

Species	Locality			
	17276	17277	17278	17279
Mollusca: Bivalvia				
Amiantis callosa (Conrad, 1837)	x	?1f	-	-
Anomia peruviana d'Orbigny, 1846	x	x	x	x
Argopecten abietis abbotti (Hertlein & Grant, 1972)	(R2f)	(R?)	(R)	-
Argopecten sp., indet.	ff	x,ff	x,ff	x
Barnea subtruncata (Sowerby, 1834)	-	ff	-	-
Cardiidae, indet.	ff	2f	2f	-
Chama arcana Bernard, 1976	-	x	x	-
Chione californiensis (Broderip, 1835)	?	x	x	-
Chione sp., aff. *C. californiensis* (Broderip, 1835)	(*R)	(R)	(R)	-
Chione fluctifraga (Sowerby, 1853)	-	-	x	?1f
Chione gnidia (Broderip & Sowerby, 1829)	(R?2f)	x	x	-
Chione picta Willett, 1944	-	1	-	-
Chione undatella (Sowerby, 1835)	x	x	x	jj
Chione sp. /spp.	ff,(R)	jj,(R)	jj,(R)	jj
Corbula sp.	-	1	-	-
Crassinella nuculiformis Berry, 1940	-	x	x	x
Crassinella sp.	-	-	1	-
Cryptomya californica (Conrad, 1837)	-	x	x	-
Cumingia californica Conrad, 1837	-	-	2f	-
Diplodonta sericata (Reeve, 1850)	x	x	x	x
Donax californicus (Conrad, 1837)	-	x	x	-
Donax gouldii Dall, 1921	1f	x	x	x
Dosinia ponderosa (Gray, 1838)	1f	ff	x	-
Ensis sp., ? *E. myrae* Berry, 1953	-	-	1f	-
Euvola vogdesi (Arnold, 1906)	(R,ff)	(R,ff)	(R,ff)	-
Florimetis obesa (Deshayes, 1855)	-	-	3f	-
Glycymeris sp.	-	*	x	-

	17276	17277	17278	17279
Here excavata (Carpenter, 1857)	-	x	-	-
Juliacorbula luteola (Carpenter, 1864)	-	x	x	x
Laevicardium elatum (Sowerby, 1833)	*	2f	2f	-
Laevicardium substriatum (Conrad, 1837)	-	x	-	-
Leptopecten latiauratus (Conrad, 1837)	3f	x	x	x-
Lucinisca nuttalli (Conrad, 1837)	x	x	x	x
Lyonsia sp. -	?1f	-	-	
Macoma nasuta (Conrad, 1837)	1f	x	x	cf.
Mactridae, indet.	-	x	x	-
Megapitaria squalida (Sowerby, 1835)	(Rff)	(?1R)	(R)	-
Nucula exigua Sowerby, 1833	-	x	x	x
Nuttallia nuttallii (Conrad, 1837)	-	*	-	-
Nutricola tantilla (Gould, 1853)	-	x	x	x
Ostrea conchaphila Carpenter, 1857	x	x	x	x
Ostrea sp.	(?R)	-	1j	-
Parvilucina approximata (Dall, 1901)	-	x	x	-
Pectinidae, indet. fragments	ff	ff	ff	x
Petricola californiensis Pilsbry & Lowe, 1932	-	1f	?1f	-
Petricola carditoides (Conrad, 1837)	-	-	2f	-
Petricolaria cognata (Adams, 1852)	3f	x	x	x
Pitar helenae Olsson, 1961, or *P. newcombianus* (Gabb, 1865)	-	x	?1	-
Protothaca laciniata (Carpenter, 1864)	-	-	1f	-
Protothaca staminea (Conrad, 1837)	?1f	-	x	-
Protothaca tenerrima (Carpenter, 1857)	-	?1f	2f	-
Psammotreta viridotincta (Carpenter, 1856)	-	2f	?1f	-
Raeta undulata (Gould, 1851)	-	2f	4f	-
Saxidomus sp.	?1f	-	1f	-
Semele decisa (Conrad, 1837)	1f	2f	3f	-
Semele pulchra (Sowerby, 1832)	-	x	x	x
Tagelus californianus (Conrad, 1837)	-	ff	ff	-
Tagelus sp., indet. (fragments)	-	ff	ff	-
Tellina meropsis Dall, 1900	-	x	x	-
Trachycardium procerum (Sowerby, 1833)	?1f	x	x	-
Veneridae, indet.	-	-	-	2f
Zirfaea pilsbryi Lowe, 1931	-	-	3f	-
Bivalvia, indet. fragments (several species)	ff	ff	ff	-

Mollusca: Gastropoda

		17276	17277	17278	17279
Acanthinucella spirata (Blainville, 1832)		-	-	1f	-
Acteocina sp./spp.		-	ff	1	-
Astraea undosa (Wood, 1828)		-	-	1f	-
Bulla gouldiana Pilsbry, 1893		-	2f	-	-
Calliostoma gemmulatum Carpenter, 1864		-	2f	2f	-
Calliostoma sp.		-	1f	-	-
Cerithidea californica (Haldeman, 1840)		-	x	x	-
Conus californicus Reeve, 1844		-	1f	2f	-
Crepidula onyx Sowerby, 1824		?2f	x	x	-
Crepidula perforans (Valenciennes, 1846)		-	x	x	-
Crepidula sp./spp., indet		x	x,jj	x	-
Crucibulum spinosum (Sowerby, 1824)		1f	x	x	-
Diodora arnoldi McLean, 1966		1f	x	x	-
Lirularia sp.		-	x	x	-
Lottia or *Collisella* sp.		-	-	1	-
Lucapinella callomarginata (Dall, 1871)		-	1	-	-
Macron aethiops (Reeve, 1847) (*s.l.*)		-	-	2f	-
Megathura crenulata (Sowerby, 1825)		-	-	1f	-
Mitrella carinata (Hinds, 1844)		-	x	-	-
Muricidae, unidentified fragments		-	x	ff	-
Nassarius mendicus (Gould, 1849)		-	1	1f	-
Nassarius mendicus indisputabilis (Oldroyd, 1927)		-	2	x	-
Nassarius tegula (Reeve, 1853)		-	x	x	-
Nassarius sp./spp. (fragments)		-	ff	1f	-
Naticidae, indet. (borings in shell)		x	x	x	x
Neverita reclusiana (Deshayes, 1839)		x	x	x	-
Ocenebra foveolata (Hinds, 1844)		-	-	ff	-
Odostomia sp.		-	1	-	-
Olivella baetica Carpenter, 1864		-	x	-	-
Olivella biplicata (Sowerby, 1825)		-	x	-	-
Olivella sp.	-	-	1f	-	
Pteropurpura festiva (Hinds, 1844)		-	-	x	-
Roperia poulsoni (Carpenter, 1864)		-	-	1f	-
Tegula aureotincta (Forbes, 1852)		-	-	2f	-
Tegula eiseni Jordan, 1936		-	?1f	?2f	1f
Tegula gallina (Forbes, 1852)		-	*	-	-
Tegula sp.		-	f	-	-
Terebra sp.	-	x	-	-	
Tricolia compta (Gould, 1855)		-	x	x	x
Turritella gonostoma Valenciennes, 1832		(R)	-	(R)	-
Microgastropods, unidentified		-	x	x	-
Gastropoda, indet.		f	x	ff	-

Mollusca: Scaphopoda				
Dentalium neohexagonum Sharp & Pilsbry, 1897	-	x	x	x

	17276	17277	17278	17279
Porifera: Demospongae				
Clionidae, indet. (borings in shell)	x	x	x	x
Bryozoa: Gymnolaemata				
Discoporella umbellata (Defrance, 1823)	-	x	-	-
Encrusting bryozoans, unidentified	-	x	x	-
Annelida: Polychaeta				
Spionidae, indet.	?	x	x	x
Arthropoda: Crustacea (Cirripedia)				
Balanus pacificus Pilsbry, 1916	-	x	x	-
"*Balanus*" (*s.l.*) sp. or spp. (unidentified)	1f	-	1f	-
Chelonibia testudinaria (Linnaeus, 1767)	*	-	x	-
Cryptolepas murata Zullo, 1961	x	x	x	-
Tetraclita rubescens Darwin, 1854	1f	3f	x	-
Arthropoda: Crustacea (Malacostraca)				
Decapoda, indet. (crab parts, etc.)	*	ff	-	-
Chordata: Chondrichthyes				
Myliobatis californica Gill, 1865 (sting ray) (teeth)	-	1	?1	-
Unidentified small shark (tooth)	-	*	-	-
Unidentified shark or ray	-	1	-	-
Chordata: class uncertain				
Small bone, class undetermined	-	1	-	-
Ichnofossils: *incertae sedis*				
Minute herring-bone pattern of tiny holes in shell	-	x	x	-

TABLE 2

Preliminary list of middle Pleistocene species from the "lower" and "upper Broadway" faunal horizons in the downtown San Diego area, based on collections made from building excavations in the Cortez Hill, Little Italy, Columbia, Marina, Gaslamp Quarter, and East Village parts of the Centre City Redevelopment Area of downtown San Diego, San Diego County, California (LACMIP and SDSNH collections). Abbreviations: (R), reworked from older unit; x, present; ff, fragment(s) only.

Species	lower	upper
Mollusca: Bivalvia		
Anadara sp. nov.?	-	x
Anomia peruviana d'Orbigny, 1846	x	x
Argopecten abietis abbotti (Hertlein & Grant, 1972)	x	(R)
Argopecten sp., aff. *A. ventricosus* (Sowerby, 1842)	-	x
Caryocorbula porcella (Dall, 1916)	x	?
Chione californiensis (Broderip, 1835)	-	x
Chione sp. aff. *C. californiensis* (Broderip, 1835)	x	x
Chione fluctifraga (Sowerby, 1853)	-	x
Chione gnidia (Broderip & Sowerby, 1829)	-	x
Chione undatella (Sowerby, 1835)	x	x
Crassinella pacifica (Adams, 1852)	x	x
Cryptomya californica (Conrad, 1837)	-	x
Cumingia californica Conrad, 1837	-	x
Diplodonta sericata (Reeve, 1850)	x	x
Diplodonta subquadrata (Carpenter, 1856)	x	x
Euvola vogdesi (Arnold, 1906)	x	(R)
Juliacorbula luteola (Carpenter, 1864)	x	x
Laevicardium elatum (Sowerby, 1833)	x	x
Laevicardium substriatum (Conrad, 1837)	x	x
Lucinisca nuttalli (Conrad, 1837)	x	x
Macoma indentata Carpenter, 1864	-	x
Macoma nasuta (Conrad, 1837)	x	x
Mactrotoma californica (Conrad, 1837)	x	-
Megapitaria squalida (Sowerby, 1835)	x	x
Mytilidae, indet. (fragment)	-	x
Nucula exigua Sowerby, 1833	-	x
Ostrea angelica Rochebrune, 1895	-	x
Ostrea conchaphila Carpenter, 1857	x	x
Ostrea sp.	x	-
Parvilucina sp.	-	x

Pinnidae, indet. (fragments, *Pinna* sp. or *Atrina* sp.)	ff	-
Pitar newcombianus (Gabb, 1865) or *P. helenae* Olsson, 1961	x	x
	lower	upper
Psammotreta viridotincta (Carpenter, 1856)	-	x
Tagelus californianus (Conrad, 1837)	sp.	x
Tagelus (*Mesopleura*) sp., indet.	-	ff
Tellina meropsis Dall, 1900	x	x
Tellina simulans Adams, 1852	-	x
Trachycardium procerum (Sowerby, 1833)	-	x
Mollusca: Gastropoda		
Bulla gouldiana Pilsbry, 1895	-	x
Cerithidea californica (Haldeman, 1840)	-	x
Crepidula sp., cf. *C. onyx* Sowerby, 1824	-	x
Crucibulum spinosum (Sowerby, 1824)	-	?
Epitonium (*Nitidiscala*) sp.	-	x
Lucapinella callomarginata (Dall, 1871)	x	-
Melampus olivaceous Carpenter, 1857	-	x
Nassarius tegula (Reeve, 1853)	?	x
Neverita reclusiana (Deshayes, 1839)	x	-
Turritella gonostoma Valenciennes, 1832	-	x
Porifera: Demospongea		
Clionidae, indet. (borings in shell)	x	x
Bryozoa: Gymnolaemata		
Encrusting bryozoans, unidentified	x	x
Arthropoda: Crustacea (Cirripedia)		
"*Balanus*" (*s.l.*) spp.	x	x
Chelonibia testudinaria (Linnaeus, 1767)	-	x
Arthropoda: Crustacea (Malacostraca)		
Decapoda, indet. pieces	-	x
Annelida: Polychaeta		
Spionidae, indet. (borings in shell)	x	x

Echinodermata: Echinoidea		
? *Dendraster* sp. (fragments)	-	ff
	lower	upper
Chordata: Chondrichthyes		
Myliobatis californica Gill, 1865 (sting ray: s, caudal spines; t, teeth)	s, t	s, t
Chordata: Osteichthyes		
Teleostei, unidentified (bony fish: o, otolith; t, tooth?)	t?	o

Figure 1. Index map of downtown San Diego, San Diego County, California, showing locations of numbered building project sites discussed in text.

Paleontology of new middle Eocene faunas and floras from northern San Diego County, southern California

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Paleontological mitigation and monitoring activities at three mass grading projects in northern San Diego County, California, have yielded new collections and data on middle Eocene invertebrate (mainly molluscan), vertebrate faunas, and associated paratropical floras. Based on more than 300 collecting localities dispersed across three projects, the 4-S Ranch housing development west of Rancho Bernardo, the Westview High School site in Rancho Penasquitos, and the Cathedral High School site in Carmel Valley, we are able to reconstruct the environmental and paleoclimatic conditions that existed in this region approximately 45 million years ago.

Volutoderminae (Gastropoda, Volutidae) from the Late Cretaceous of the Pacific slope of North America

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Large volutid gastropods of Late Cretaceous (Coniacian through Maastrichtian) age from southern British Columbia, Canada, to Baja California, Mexico, have commonly been identified as *Volutoderma averillii* (Gabb, 1864). Review of available specimens results in assignment to three genera: *Volutoderma* Gabb, 1877, with eleven (possibly twelve) species, eight (or nine) of them new; *Longoconcha* Stephenson, 1941, with one new species; and *Retipirula* Dall, 1907, with one new species.

The species of *Volutoderma* appear to form three lineages. 1) The earliest in occurrence and longest in time range is the lineage which includes the type species of *Volutoderma*, *Fusus averillii* Gabb, 1864. The *V. averilli* lineage comprises *Volutoderma* n. sp. q (Coniacian-Santonian age), *V. averillii* (early Campanian-early middle Campanian age), *Volutoderma* n. sp. b (middle Campanian to early late Campanian age), *Volutoderma* n. sp. j (late Campanian age), and *Volutoderma* n. sp. p (latest Campanian-early Maastrichtian age). If *Volutoderma*? n. sp. of late Maastrichtian age belongs to this lineage, the *V. averillii* lineage ranges in age from Coniacian to late Maastrichtian. 2) The second lineage ranges in age through middle and late Campanian and contains three new species of *Volutoderma, Volutoderma* n. sp. a, *Volutoderma* n. sp. e, and *Volutoderma* n. sp. y each of which had a duration of over 2 Ma. 3) The third lineage ranges in age from early to late Campanian and comprises *V. santana* Packard, 1922, *V.*

magna Packard, 1922, and *Volutoderma* n. sp. aa. The genus *Volutoderma* has been widely used for Cretaceous volutes, but the genus appears to be endemic to the Pacific Slope of North America. The similar Gulf Coast genus *Volutomorpha* Gabb, 1877, is fully glazed by a callus coat.

Longoconcha n. sp. e, of latest Campanian to early Maastrichtian age, is the first species of *Longoconcha* to be recognized from Pacific Slope deposits. This genus has otherwise been reported from the Late Cretaceous of the Gulf Coast and Europe.

Retipirula n. sp. c, of late Maastrichtian age, is the first species of this otherwise early late Paleocene genus to be reported from the Cretaceous.

Only the *Volutoderma averillii* lineage has been found north of San Francisco. Because species of the three lineages and *Longoconcha* n. sp. e co-occur at southern California localities, species diversity of volutodermines in southern localities is two or three times greater than at northern localities. The presence of the Tethyan bivalve rudistid *Coralliochama* in the same formations as three-fourths of these southern Volutoderminae occurrences suggests that the diversity is linked to warm temperate to subtropical conditions.

Paleontologic record of the pseudomelaniid gastropod *Trajanella* from the marine Cretaceous of the Pacific slope of North America

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Trajanella is a tropical to marginally tropical, nearshore-marine pseudomelaniid gastropod primarily associated with the Old World Cretaceous Tethyan realm. The genus originated in western Europe and the Black Sea area during the latest Jurassic (Tithonian). It arrived onto the Pacific Slope of North America (northern California), possibly in the Aptian, but certainly by the late early Albian and, most likely, by way of Japan and the north Pacific gyre. Worldwide, the genus had its peak diversity during the Albian and Cenomanian. The only other Western Hemisphere records of *Trajanella* are a species from the Campanian of Jamaica and a possible species from the Coniacian of Texas.

Six species are recognized by us. Four are previously named species but were misallocated to genus *Acteonina*. Only *Trajanella acuminata* Anderson, 1958, was originally correctly identified. It is from upper lower Albian strata in Shasta County, California. The other species are: *Trajanella calafia* (Stewart, 1927) from possible Aptian or Albian strata in Shasta County, California; *Trajanella colusaensis* (Anderson, 1958) from upper Albian to Cenomanian strata in Shasta and Colusa counties, California; *Trajanella californica* (Gabb, 1864), from upper Cenomanian to Turonian strata in the Vancouver Island area of British Columbia, southwestern Oregon, northern California, southern California, and possibly Cedros Island of Baja California, Mexico; *Trajanella ursula* (Anderson, 1958) from Coniacian strata in Shasta County, California;

and a new species from upper Santonian to lower and possibly middle Campanian strata in the Vancouver Island area, northern California, and southern California.

Most of the Pacific Slope of North America species are represented by a few specimens, but when plentiful, there is variation in overall shape between juvenile and adults, with the last whorl of the adults becoming more cylindrical with growth.

Overview of Late Cretaceous marine gastropods from the Chatsworth Formation, Simi Hills, Southern California

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The marine Chatsworth Formation (middle Campanian to lower Maastrichtian) crops out in the Simi Hills of Los Angeles and Ventura counties, southern California. Most of the exposed formation consists of non-fossiliferous deep-sea fan deposits, but some exposures consist of fossiliferous slope facies. Molluscan fossils have been known and collected from these slope deposits for almost 100 years, but have not been studied in detail until now. This study of the gastropods is based on specimens from the Los Angeles County Natural History Museum's Invertebrate Paleontology Collection and is currently ongoing.

Fossil localities are most numerous in Bell and Dayton canyons, near the stratigraphic bottom of the exposed section in the southeastern Simi Hills. Fossils are not found in living positions, but were transported by slope failures or turbidity flows and concentrated in beds at bathyal depths (Almgren, 1981). The fauna is diverse, consisting of mollusks, crinoids, brachiopods, crabs, shark teeth and possible worm tubes. Preservation is typically moderate to poor, and many specimens are broken. About 20 gastropod families, 30 genera and 35 species are represented in the collections. In addition, there are several undescribed new species.

The most common genera are: the ringiculid *Biplica*; the trochid *Atira*; naticids *Gyrodes* and *Euspira*; aporrhaids *Anchura* and *Lispodesthes*; three species of *Turritella*; and the perrissityid *Perissitys*. Possible new taxa may include representatives of three fasciolariid genera: *Graphidula*, *Anomalofusus* and *Fusinus*.

Although the gastropod fauna of the Chatsworth Formation is indicative of a warm-water, shallow-shelf environment, taxa characteristic of tropical Tethyan waters have not been recovered. Water temperatures were probably warm-temperate in the area and may reflect cooling during the middle Campanian.

Compared to other west coast Upper Cretaceous formations which have yielded one or more of the Chatsworth Formation gastropods, the Chatsworth gastropod fauna is most similar to that of the Campanian strata in the Santa Ana Mountains, Orange County, California. About two-thirds of the Chatsworth Formation gastropods are also found in the lower upper Campanian Pleasants Sandstone of the Williams Formation and the middle Campanian Holz Shale of the Ladd Formation in the Santa Anas. This is attributable to the geographic proximity of the Simi Hills and Santa Ana Mountains during the Late Cretaceous (Link, Squires and Colburn, 1984).

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FOSSIL GASTROPODS FROM THE CHATSWORTH FORMATION

Trochidae Rafinesque, 1815
Subfamily Margaritinae
Atira ornatissima (Gabb, 1864)

Zygopleuridae Wenz, 1938
Zebalia suciaensis (Packard, 1922)

Turritellidae Lovén, 1847
Turritella chicoensis Gabb, 1864
Turritella chicoensis pescaderoensis Arnold, 1908
Turritella ossa Popenoe, 1937

Aporrhaidae Gray, 1850
Anchura phaba Elder and Saul, 1996
Lispodesthes rotundus (Waring, 1917)
Teneposita laeva Loch, 1989

Perissityidae Popenoe and Saul, 1987
Forsia popenoei Saul, 1988
Murphitys corona (?) Popenoe and Saul, 1987
Perissitys brevirostris (Gabb, 1864)
Perissitys pacifica Popenoe & Saul, 1987
Zinsitys kingii Saul, 1988

Calyptraeidae Lamarck, 1809
Lysis suciensis (Whiteaves, 1879)

Ampullinidae Cossman, 1918
Ampullina packardi Popenoe, 1937

Naticidae Forbes, 1838
Euspira compressa (Waring, 1917)
Gyrodes (*Sohlella*) *canadensis* (Whiteaves, 1903)
Gyrodes (*Sohlella) pacificus* Popenoe, Saul & Susuki, 1987

Cassididae Latreille, 1825
Haydenia impressa (Gabb, 1864)

Epitoniidae Berry, 1910
Acirsa nexilia (White, 1889)
Belliscala suciense (Whiteaves, 1879)
Opalia? mathewsonii (Gabb, 1864)

Buccinidae Rafinesque, 1815
Eripachya ponderosa (Gabb, 1864)
Pentzia hilgardi (White, 1889)

Fasciolariidae Gray, 1853
Anomalofusus sp.
"Fusus" tumidus Gabb, 1864
Graphidula sp.

Volutidae Rafinesque, 1815
Volutoderma averillii (Gabb, 1864)
Volutoderma sp. a
Volutoderma sp. b

Mathildidae Dall 1889
Mathilda? Semper, 1865

Acteonidae d'Orbigny, 1842
Neoacteonina obesa Dailey & Popenoe, 1966

Ringiculidae Philippi, 1853
Biplica obliqua (Gabb, 1864)

Scaphandridae Sars, 1878 (=Cylichnidae A. Adams, 1850)
Ellipsoscapha nortonensis (Anderson, 1958)

Siphonariidae Gray, 1840
Vasculum obliquim White,1889

III. PHYLOGENETICS SYMPOSIUM

Organized by Doug Eernisse
California State University, Fullerton

Genetic signatures of patellogastropod dispersal

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The ecological effects of larval dispersal capabilities in marine invertebrate life histories have long been recognized, but their implications for evolutionary events such as speciation, extinction, and genetic population structuring, have only recently been experimentally studied using molecular data. We sampled the cytochrome oxidase I gene (COI) from three North Pacific patellogastropod species co-occurring on coralline substrates in the nearshore subtidal throughout the Aleutian Islands, Alaska. *Tectura testudinalis*, *Erginus sybaritica* and *Erginus apicina* all feed on coralline algae, however *T. testudinalis* is a broadcast spawner while *E. sybaritica* and *E. apicina* are brooders. We hypothesized that these differences in reproductive strategy would be reflected in each species' genetic population structure. Taxa were chosen based upon their similar biogeographic range, presumed ecological similarities and phylogenetic position. COI data indicate that population structure is directly affected by reproductive life history strategies when the ecological context of the study organisms is held constant and phylogenetic effects are accounted for, giving us a better measure of dispersal's contribution to population structure.

Octopod molecular phylogeny

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Octopod systematics is difficult and at present still unstable. The most recent classification published (Sweeney and Roper, 1998) is largely based on the presence or absence of a very few morphological characters. Morphologists argue about the diagnostic importance and reliability of most of the morphological and anatomical characters. They are scarce in octopods and many other characters are under discussion or need to be critically redefined.

Molecular techniques have proved to be powerful tools to resolve phylogenetic relationships. They also provide an independent approach to test hypotheses based on morphological analyses.

We are currently reviewing the octopod systematics using both approaches in order to draw stable and reliable phylogenetic relationships and taxa diagnoses. We present here the results of the molecular investigations using the 3'end of the LSU rRNA gene (16S, around 500bp) for the Cirroctopoda and the catch-all genus *Octopus* (3 of the 4 species-groups recognised).

The molecular marker used is able to resolve well the Cirroctopoda relationships. Revisions in the systematic classification of cirrates have been proposed (Piertney et. al., 2003).

- *Cirrothauma*, *Cirroteuthis* and *Stauroteuthis* : to be united in the Cirroteuthidae
- *Opisthoteuthis* : to be in the Opisthoteuthidae
- *Cirroctopus* : to be placed in a new family

The resolution power of the gene used is not giving as well supported results in the case of the genus *Octopus*. However, based on both morphological and molecular investigations we were able to propose some important clarifications of the octopod classification (Hudelot et al., in prep).

- *Eledone palari* : to be placed in new genus A.
- *Aphrodoctopus* : to be reassigned to the genus *Eledone*
- "*aegina* species-group" species : to be placed in the genus *Amphioctopus*
- "*macropus* species-group" species : to be placed in the genus *Callistoctopus*
- genus *Octopus* sensu stricto : to be redefined

These are only the preliminary results and octopod systematics is likely to undergo major changes in the future years.

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Host choice and genetic divergence in sacoglossan populations

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The oceans pose special challenges for understanding speciation. Planktonic larval stages achieve considerable dispersal for many marine organisms, facilitating gene flow between populations. However, despite potential widespread mixing of propagules, molecular studies often reveal cryptic species in the sea. Theory holds that habitat preference can promote reproductive isolation, even in sympatry, but examples are lacking. The opisthobranch *Alderia modesta* is a cosmopolitan species found on its obligate adult host, yellow-green algae in the genus *Vaucheria.* Larvae settle in response to carbohydrates produced solely by the host alga. Recent studies have revealed a cryptic break between populations of *A. modesta* in the Pacific northwest. Populations south of Morro Bay have small adults that express a reproductive polymorphism, producing either planktotrophic or lecithotrophic larvae; populations from northern California and Oregon have large adults that produce exclusively planktotrophic larvae. Allozyme surveys showed that different alleles were nearly fixed in northern and southern populations, indicating a lack of gene flow despite the potential for larval transport via along-shore currents. Populations from Oregon and southern California were 18-20% divergent at the DNA sequence level, indicating prolonged isolation and probable cryptic speciation. Preliminary bioassays indicate that larvae from Californian parents do not settle on *Vaucheria* from Oregon, suggesting that appropriate settlement cues may only be locally available for larvae of these co-evolved habitat specialists. Being non-reproductive, larvae can move between habitats without causing gene flow if metamorphosis does not occur; any block to larval settlement will therefore generate pre-mating isolation. Behavior promoting habitat fidelity may thus result in differentiated populations despite the potential for migration in marine ecosystems.

Comparative phylogeography of two eastern Pacific eelgrass mollusks - Taylor's seahare (*Phyllaplysia taylori*) and the painted limpet (*Tectura depicta*)

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Eelgrass habitats along the Eastern Pacific are threatened ecosystems. Both direct habitat loss and anthropogenically induced modification through eutrophication, dredging, filling and pollution have resulted in declines of many of the organisms that depend on these habitats. We investigated the effect of reproductive strategy on genetic structure in two eelgrass specific mollusks, Taylor's seahare (*Phyllaplysia taylori*) and the painted limpet (*Tectura depicta*). The

seahare utilizes direct development, while the limpet presumably employs planktonic larval dispersal. We obtained mitochondrial DNA cytochrome b sequence data from northern Vancouver Island to Southern California for the seahare, and from central and southern California for the limpet. Our data for the seahare suggest geographic structure that corresponds to zoogeographic breaks of other marine and estuarine taxa of the eastern Pacific. Our data for the limpet indicate significant genetic structure that corresponds to morphology.

The role of molecules in understanding molluscan evolution

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The phylum Mollusca is one of the largest animal phyla, with diverse body plans and an extensive fossil record. Some of the molluscan classes are so modified that phylogenetic reconstruction within the phylum, based on morphological characters has been controversial. With the advent of molecular techniques, sequence data has become an alternative source of phylogenetic characters. Initially, nuclear ribosomal small subunit (18S) data was widely used, mainly to understand the relationship of molluscs with other protostome groups. Recently, 18S data have been used to investigate relationships between the different classes. A few other gene fragments have been used to address relationships within certain classes. In addition to the sequence data, developmental genes and mitochondrial gene order data have become available for several groups. I intend to provide an overview of the current status for the different types of molecular data and what direction research is taking in the study of molluscan evolution.

So what is a species anyway? - A phylogenetic approach using cowries

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The question, "What is a species?" has plagued evolutionary biologists for centuries. In the study of cowries, this question has often been reworded and asked, "So is XX a valid species or not?" or "So how many species are there?" By far, because of the group's familiarity, these questions dominate; and molecular approaches are perceived to provide the answers. Using a large comparative molecular database, I will establish objective criteria based on monophyly, coalescence, divergence and geography for recognizing evolutionary significant units that may, or may not, be considered species. Evidence will be presented that demonstrate how the same data can be interpreted differently by both lumpers and splitters. Moreover, I will show how additional data can overturn initial assumptions, how comprehensive sampling matters, and why we are hung up on the issue. In the end, I conclude that, depending on one's question, the "species" really may not matter if it is the process one wishes to explain.

IV. OPISTHOBRANCH SESSION

Reports from the field: Bridging the gap between recreational scuba divers and scientists

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Thousands of recreational scuba divers and dive guides observe marine life all over the world every day. A lot of these divers have a keen interest in marine biology. Opisthobranchs are easy to observe and photograph and many divers find them especially attractive. Reports and photographs from sport divers can document the distribution, size and color variations of opisthobranchs. Anyone with an interest in marine wildlife can record sightings and behaviors such as crawling, swimming, hunting, feeding, courting, mating and spawning. Reports of rarely seen species are particularly valuable. Scuba divers have been the first to document many species new to science. Most dive guides have extensive knowledge of the fauna in their area and can be important sources of information.

Since the cost of field trips to remote locations is very high, reports from recreational divers and dive guides can be a valuable asset to science. Until recently, the information and images recorded by sport divers have not been available to the scientific community. The Internet has become an important way for marine naturalists to share their findings with the marine scientists.

The author will present recent opisthobranch findings from the Solomon Islands, Indonesia, the Phoenix Islands, Thailand and Myanmar.

The genus *Armina* (Gastropoda: Nudibranchia: Arminidae) in the western Atlantic: New species and a phylogenetic analysis

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With more than 50 nominal species, *Armina* is the species-richest genus of the family Arminidae, and includes the most derived forms of the group. Features shared by members of this genus are the continuous anterior mantle margin, the presence of branchial and hyponotal lamellae, and the close distance between the rhinophores. Although *Armina* exhibits a world-wide distribution, only five species have been recorded in the western Atlantic. However, the western Atlantic record of *Armina tigrina* Rafinesque, 1814, needs confirmation (Ardila &

Valdés, 2004). Southern Caribbean members of the nudibranch genus *Armina* Rafinesque, 1814 are reviewed. *Armina juliana* Ardila and Díaz 2002 and *Armina muelleri* (Ihering, 1886), two previously described species, are redescribed and the reproductive systems illustrated. A new species, *Armina* n. sp., is described based on a single specimen collected from Colombia. The number of notal ridges, the size and the shape of the radular teeth, the features of the masticatory processes, and the morphology of reproductive system are the main distinguishing characteristics between the new species and other Atlantic members of this genus. *Armina* n. sp. is the second species of the family Arminidae described from the Caribbean of Colombia. A phylogenetic analysis provides support for the hypothesis that *Armina* is a monophyletic group and that *A. juliana, A. muelleri*, and the new species belong in this group.

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Biogeographic patterns of opisthobranch mollusks in the Gulf of California: Dispersion or vicariance?

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The disjunct distribution of opisthobranch mollusks in the Gulf of California may be explained by two hypothesis: vicariant events that took place in the past, forming the Gulf of California, and the last glacial period, or a dispersal process involving “gaps” that function as biographical boundaries between known distributional centers (Californian and Panamic).

Unfortunately, no solid evidence is available (fossil record), just “abnormal” records of species that have been found at long distances from their expected geographic ranges. These records may be evidence of the capability of opisthobranchs to be transported to other areas.

Temporal and spatial variations of the Opisthobranch Fauna near La Paz, Baja California Sur, México

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The ecological study of opisthobranch communities is fairly recent, often due to their small size, low abundance, lack of knowledge of preferred habitats, and nontraditional (that is not transect and quadrat) research methodology. In the past, these reasons have excluded them from more common quantitative studies of marine fauna. The majority of studies done on this group are taxonomic, although some have briefly mentioned aspects like type of substrate, depth, food and type of eggs.

Our three study sites were near La Paz (Calerita, Punta Pericos and Isla Cerralvo), with intertidal and subtidal habitats. We made monthly samplings from October 2000 to October 2001. We counted 1575 total organisms distributed among 74 species, of which nine are present in the four habitats, three exclusive to Calerita (intertidal), five to Punta Pericos (intertidal), ten to Isla Cerralvo (subtidal) and thirteen to Punta Pericos (subtidal). Six new range extensions were found.

The Shannon diversity index does not show any temporal tendency, the cluster analysis shows a slight similarity between the subtidal regions (49%), and for the intertidal the similarity is greater (53%). The results indicate that the dispersion of data (diversity values), as well as the fluctuations between orders in each locality, are determined by the temperature and the substrate in each of them.

Preliminary phylogeny of the genus *Thordisa* Bergh, 1877 (Discodorididae, Doridacea, Nudibranchia) with descriptions of six new species

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The dorid genus *Thordisa* Bergh, 1877, shares digitiform oral tentacles and a notched and bilabiate anterior foot with all members of the clade Discodorididae. The characters traditionally used in taxonomy to assign species to the genus *Thordisa* are: 1) pectinate marginal teeth, and 2) conical papillae on the dorsal notum. So far, thirty-three nominal species have been described,

but no general taxonomic revision is available. Here, I provide the re-description of several species and the description of six new species. External morphology and complete internal anatomy (including radula and reproductive system) were investigated with dissection and SEM. A preliminary cladistic analysis confirms the monophyly of *Thordisa*. Phylogenetic relationships between species included in this analysis are proposed. Biogeographical distributions are discussed in a historical perspective.

Phylogeny of *Halgerda* (Mollusca: Gastropoda) contrasting mitochondrial DNA (COI) and morphology

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A phylogeny of the nudibranch *Halgerda* is presented based on mitochondrial COI and compared to a morphology-based phylogeny. Both separate and combined analyses resulted in trees that were very similar in topology, both to each other and to the previously published morphology-based tree albeit with lower consistency and retention indices. Some differences are noted in the topology based on the optimality criteria used: parsimony and maximum likelihood. Results of this study indicate that the COI gene contains sufficient phylogenetic signal for inferring species-level phylogeny in the Nudibranchia and also supports many of the clades in the morphological phylogeny. Specifically, the more basal clades of the morphology-based phylogeny are supported with differences noted at the most terminal taxa.

Systematics and phylogeny of the nudibranch genera *Okenia* and *Hopkinsia*

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Representative species of *Okenia*, *Hopkinsia* and *Sakishimaia* were studied anatomically, including six undescribed species of *Okenia* from the tropical Indo-Pacific and four from the eastern Pacific. The addition of these undescribed taxa greatly expands our understanding of the anatomical variation present within *Okenia*. These studies demonstrate consistent differences in external body form, presence of oral glands, radular morphology and reproductive anatomy. These features were then subjected to phylogenetic analysis. The results of this study indicate that *Okenia mediterranea* (von Ihering, 1886) is the sister species to all other taxa studied. It retains several symplesiomorphies with the out group taxa of *Goniodoris* and *Diaphorodoris*. This species needs to be placed in a new genus to preserve the monophyly of the remaining genera. *Okenia* and *Hopkinsia* are sister taxa to each other. *Sakishimaia* is nested within

Hopkinsia and must be considered as a synonym of *Hopkinsia* in order to maintain the monophyly of all higher taxa. The suggested unique characteristics of the *Sakishimaia* are not evident in the present examination of material and the description of *Sakasimaia kondoi* is expanded here. It shares radular similarities with *Hopkinsia hiroi* and other features with other species of *Hopkinsia*. The evolution of ecological specialization of this clade on bryozoans and colonial tunicates is discussed within this phylogenetic context.

Toward a phylogeny of chromodorid nudibranchs: Which questions can COI help answer?

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The chromodorid nudibranchs are an amazingly diverse group, encompassing 1000 species. Most recent systematic studies of this group have either been simple descriptions of new species or have focused on similarly colored species from different genera (color groups). Gosliner and Johnson (1999) tested the monophyly of the genus *Hypselodoris* and identified morphological synapomorphies that separated hypselodorids from the rest of the chromodorids. We also presented a preliminary phylogeny of all of the chromodorids based on morphological data from the literature. We were not able to find consistent synapomorphies for every genus and we found a continuum of character variation across many different genera. Molecular markers may be helpful in separating some of these problematic groups. I have sequenced the mitochondrial cytochrome oxidase I gene for 30 chromodorid nudibranchs. I will present the preliminary phylogenetic results from this gene and discuss its usefulness in understanding relationships in this group.

References

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The nudibranch family Eubranchidae from the eastern Pacific

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Aeolid nudibranchs in the family Eubranchidae are small hydroid feeders with swollen cerata, a triserrate radula and an acleioproct anus. A number of genera have been proposed for the 38 described species. Most of these genera were subsequently synonymised into one genus, *Eubranchus*, prior to 1998 when Alexander Martynov revised the family into seven genera. This talk presents a phylogenetic analysis of the family with a suggested re-assignment of genera. The eastern Pacific species are briefly reviewed and several undescribed species are presented.

The systematics of *Roboastra* Bergh, 1877 (Nudibranchia, Polyceridae, Nembrothinae)

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The genus *Roboastra* was described by Bergh (1877), with *Roboastra gracilis* as type species. A few species have been described since then, but some of them are currently regarded as synonyms. A review of the literature shows that there are five nominal species of *Roboastra*, but their original descriptions as well as a few additional published studies offer limited information. This lack of information has produced a great deal of confusion in the literature, including field guides and web sites, which often contain misidentified photographs.

The genus *Roboastra* is characterized by having large oral tentacles developed as dorso-laterally grooved cylindrical projections equal in length to the rhinophores, radular rachidian teeth reduced, with three well-defined denticles, and a small prostatic gland confined to a coiled glandular section of the vas deferens (Burn 1967). *Roboastra* is distributed throughout tropical and temperate areas in the Atlantic, Eastern Pacific and Indo-Pacific.

The phylogenetic relationships within *Roboastra* are unknown, as well as the position of this group in the phylogeny of the phanerobranch dorids. In the present paper we conducted a preliminary review of the species included in this genus and a study of their phylogenetic relationships based on morphological characters.

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V. GENERAL SESSION

Biodiversity and biogeography of upper slope and continental shelf epifaunal molluscan assemblages from the Caribbean Sea

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Epifaunal mollusk data from the southern Caribbean (Colombian upper slope and continental shelf; 9 to 12° N, 71 to 77° W) covering 69 sites in a range of water depths (20-500 m) were used to study assemblage patterns and spatial variability, and to evaluate different measures of diversity. A total of 13617 specimens were identified to species level and quantified. A total of 253 species was found, of which 126 (50%) of them are first records for the Colombian Caribbean and six species are new to science. Of these recorded species, 61% were restricted to one or two sites, and 43% were represented by one or two individuals. No species spanned the entire sampling area. Gastropods includes the greatest species number, followed by bivalve class. In terms of abundance, bivalves were the best represented. Multivariate analysis showed assemblages whose structure and composition seem to be mainly determined by depth and geographic gradient. Alpha diversity (sample species richness) was highly variable (2-29 species) and showed evidence of a relationship to a bathymetric gradient. Whittaker's beta diversity measure (ß, extent of change in species composition among stations), and multivariate measurements of beta diversity (number of shared species, complementarity and Bray Curtis dissimilarity) were strongly influenced by depth. Shallow assemblages (20-70 m) showed the highest beta diversity, while those deep assemblages (300 and 500m) showed the lowest beta diversity, but the highest alpha diversity. Finally, upper slope Colombian Caribbean malacofauna (300-500 m) have a broad distribution in the Tropical Western Atlantic, with only a small percentage exclusive to the southern Caribbean. This distributional pattern results from a reduced

rate of faunal change, because of broad dispersion of larvae, the greater antiquity of fauna in deep environments, and lower susceptibility to regional changes in the abiotic conditions.

Comments on malacological research in the Gulf of California, Mexico

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There is a rich tradition of malacological research within the Gulf of California. Most of the research done by Mexican institutions has focused on molluscs of commercial value, whereas U.S. researchers have tended to engage in more basic scientific research (taxonomy, natural history, biogeography, etc.).

This presentation will discuss some of the expeditions and research projects by major United States institutions and individuals in the Gulf of California. It will also include anecdotal remarks about the individuals and their experiences. As John Steinbeck wrote, "This is a very holy place, and to question it is to question a fact as established as the tide" (Log from the Sea of Cortez, chapter 17).

Particular emphasis will be placed on the central Gulf of California, especially from Bahía de los Ángeles to the Loreto region (approximately 29°30' N to 25°30' N).

Recent cultured Chinese fresh water pearls of various shapes please pearl buyers and sellers in America

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Geologically speaking, pearly Unionidae mussels only date back to the Tertiary time (Moore, 1969) falling just prior to the geologically Recent in Asia. The Tertiary period began about 25,000 years ago and the Recent period began about 15,000 years ago. In Asia today there are many freshwater bivalve Unionidae species of Mollusca, both small and some large enough to be of commercial importance

Pearly shells are not restricted to fresh water bivalves (Burch 1995b). Indeed many marine mollusks are used commercially, especially the enormous Australian *Pinctata maxima* Jameson, 1901, in the marine family Pteriidae (Hedley, 1916). This has been used since the middle of the 1880s for salad plates, butter spreaders, and pearl handled table knives. Other marine bivalves with mother of pearl include members of the families Mytilidae and Pinnidae (Burch, 1995a,b). Marine pearly gastropods include Trochidae and Haliotidae (Burch, 1995c). Other pearly marine mollusks include Cephalopoda, such as the Tertiary to Recent *Spirula* which is not used commercially and the larger *Nautilus* (Burch, 1995c) which are protected in Hawaii but are still used for ornaments elsewhere.

The enormous river system of China permits several freshwater species of the bivalve family Unionidae to be utilized commercially, although *Cristaria plicata* (Leach, 1814) is less common now due to long over-exploitation over the centuries. The Unionidae species used in China now is *Hydriopsis bilata* (Simpson, 1902) (Ward, 2002 p. 52).

I first became fascinated by pearly objects in San Francisco's Chinatown back in the 1920s. The Chinese have made pearly Buddhas since about 500 BC (Ward, 2002) by inserting images in freshwater mussels which were removed when they were covered with pearly nacre. These were sold individually as religious objects (but to me merely as pearly objects). They were five cents each, or six for twenty-five cents.

Upon moving to Oahu, Hawaii in 1970, my husband (Thomas) and I began to gather nacreous objects such as mother-of-pearl salad plates, an umbrella handle, opera glasses, button hooks, etc., in antique stores in Honolulu, and in various cities when on visits to the mainland, and even on the internet's eBay.

We started attending the Douglas Merchandise and Jewelry wholesale shows in Blaisdell Center in Honolulu in 1979 and purchased a delightful Chinese freshwater pearl necklace. It is 34 inches long and consists of joined pairs of 4 mm white pearls (Plate 1, figure A). We enjoyed attending these Trade Shows and admired the conventional round pearls from Japan, Tahiti and other places in the Pacific. We even bought some from Tahiti but I preferred the Chinese and Japanese freshwater pearls. Also there were amazing Chinese freshwater mother-of-pearl gaming counters, (Burch, 1995d), probably modern, although mentioned in Desolation Island, one of Patrick O'Brian's delightful sea stories of the Napoleon Bonaparte war in the late 1700's and early 1800s. Another source for information on gaming counters is Seymour (1985).

In 1994, Honolulu was chosen as the site for the First International Pearl Conference for professional pearl workers in freshwater and marine pearl industries. The conference was attended by 645 people from all around the world. It was an impressive combination of lectures and exhibits. I also met two pearl editors: Richard Torrey of Pearl World, an international journal, and Neil Sims of the Pearl Oyster Bulletin put out by a consortium from France and New Caledonia. The conference was managed by Crest International with local chairman Mr. C. Richard Fassler of the Hawaii Department of Land and Natural Resources, Aquaculture Development Program. As program chairman, Mr. Fassler asked me to prepare an exhibit on pearls. So, with the help of my husband, my daughter (R. Janthina DuSavage) who sent us labels and graphics from her home in Washington, Regina Kawamoto of the Mollusca department and Arnold Suzumoto of the Fish department of the Bernice P. Bishop Museum of Cultural and Natural History (where I was a staff member), the contractor (Patrick Myers) working on our house, and zoological and Malacological friends from museums and universities around the world we prepared an exhibit using 16 glass and mahogany cases from the Hawaiian Malacological Society (Burch, 1994). Sadly only professionals in the pearling world were able to attend the conference but anyone could come and see the displays.

Although the "Pearls 94" Conference brochure had photographs of unusually shaped pearls, it wasn't until 1997 that the vendors at the Douglas Trade Shows began to include such pearls for sale. Omar's Wholesale Black Tahitian Pearl Company had four small exquisite deeply lustrous and gorgeously oriented small white pearl sticks, overlying two or more fancy shaped sticks. Also at the LuCcoral Museum in Honolulu was a pearly dragon fly (plate 1, fig. B) and I realized people were working on a new form of pearl. In 1999 while at the Pacific Pearls booths, I saw

strikingly different Chinese freshwater pearls shaped like coins. Three of these are shown in plate 1, figure C. One is peach, one white, and one faintly pink. Thus along with booth after booth of gorgeous spherical pearls a new art form was beginning to appear. However it took until 2002 before the first printed notice of coin pearls were shown in Pearl World.

Both the 2002 and 2003 April-May-June issues of Pearl World had dealer listings and summaries showing the number of dealers selling the following types of pearls at the Jewelry Show at Tucson, Arizona.

2002: 6 dealers had coin pearls. No dealers had other non spherical pearls.

2003: 13 dealers had coin pearls, 12 had baroque pearls and 12 dealers with other shapes.

Lois Berger in the 2002 and 2003 Pearl World presented lists which, among other things, indicated that many dealers thought that the pearls were harvested too soon and had insufficient nacre. Only coin pearls had a very high luster and the flat rectangular pearls had strong orient. (Luster is the sharpness and intensity of images reflected from the pearl surface. Orient is the underlying deep iridescent play of color.)

Pacific Pearls was one of the 13 dealers listed in Pearl World in 2002 and 2003 and in April 2003 Marcia Fentress of that organization agreed to send me an assortment of pearl necklaces and strands of fancy shaped pearls. I soon received a magnificent assortment. (All the pearls shown on plate 2 are from this shipment.) Included were many strands of non spherical shapes including picket fences, squares, rectangles, ovals, and double paired rounds. Some were dyed and some were natural color. A strand is 16 inches and a necklace may be either 16 or 32 inches. All have a mother-of-pearl nucleus cut to the desired shape which is implanted in the mussel and on which an additional nacreous layer is deposited.

Also included in the shipment were paired stubs for earrings of two overlapping coin pearls. Other non spherical pearls included were a strand of white rhomboid 9 x 15 mm drilled point to point along the long axis, one 34" necklace of white rectangular 9 x 15 mm pearls drilled along the long axis, a beautiful 16 mm coin necklace with a modified top, two beautiful single unblemished 16 and 18 mm peach coins, two slightly overlapping pairs of 12 mm white coins. Also there were two squares which were highly lustrous and both sides with great orient. Last of all there was one Kasumi ga-ura, a Japanese freshwater pearl solitary, almost a spherical 14 mm pearl. This last was an indication of what Japanese freshwater pearls can be.

A later shipment in July 2003 from Marcia Fentress and Fuji Voll, co-owners of Pacific Pearls, shows that in addition to the Chinese pearls discussed above there also will be an increased supply of Japanese freshwater pearls and shells that will furnish enjoyable new jewelry involving man and his imaginative jewelry for American buyers.

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* These may be available from Mr. William Ernst, Corresponding Secretary, Hawaiian Malacological Society, 94-641 Hikianalia Pl., Miliani, HI 96789.

Plate Explanations

Plate 1A. Necklace of joined pairs of 4 mm white pearls 34 inches long purchased in Honolulu in 1979.

Plate1B. Pearl Dragonfly with 38 mm wings and a 40 mm body purchased from Lucoral Museum in Honolulu in 1997.

Plate 1C. White, peach, and pink 14 mm coin pearls purchased from Pacific Pearls of Mill Valley, California in 1999.

Plate 2A. A 16 inch strand of 13 mm salmon coin pearls purchased from Pacific Pearls of Mill Valley, California in 2003

Plate 2B. A 16 inch strand of grey dyed 12 mm square pearls strung tip to tip purchased from Pacific Pearls of Mill Valley, California in 2003.

Plate 2C. A 16 inch necklace of 8 x 16 mm salmon picket-fence pearls purchased from Pacific Pearls of Mill Valley , California in 2003.

Figure 1

Figure 2

Withering syndrome in abalone from Baja California, México

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In 1992 the first data on the mass mortality of black abalone *Haliotis cracherodii* from the Channel Islands of southern California in the middle 1980s were published. Abalone populations were devastated along the islands; between the 95 and 100% of abalones were lost with mortalities spreading along the California coast. The epizootic spread of mortalities throughout the Channel Islands and to the coast of California suggested the role of an infectious etiological agent. Clinical analysis of abalone showed weakness, lethargy, shrunken appearance of foot muscle, mantle retraction, poor gonadal development, the inability to tightly adhere to the substrate and death. All these symptoms were collectively named Withering Syndrome (WS). In 1995 a strong pathogen-disease association was suggested. The pathogen was described as an intracellular rickettsia-like prokaryote (RLP). Several authors have admitted the association of RLP and WS indirectly by the injection of antibiotics in diseased abalone, and their subsequent recovery. The RLP was identified as a unique taxon and given the provisional status of "*Candidatus Xenohaliotis californiensis*."

Several years after detection of WS in California, USA, the question on the presence of this disease in Baja California, México, began to appear. Some authors have recorded that some abalone exemplars from México showed clinical signs of WS, and the presence of "*Candidatus Xenohaliotis californiensis*" has been confirmed. However, no records on mass mortality of black abalone or other abalone species in México were documented in the mid-eighties or today. This work describes the studies on WS carried out in México comparing their findings with those observed in California.

Reproductive cycle of the Japanese oyster *Crassostrea gigas* cultured in Bahía Falsa, Baja California, México

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The gonadal development of cultured oyster (*Crassostrea gigas*) was studied in Bahía Falsa, B.C., México, from May 1996 to April 1997. Two localities were considered, and oysters were grouped in accordance with their positions in the upper, middle and lower levels of the cultivants. A general reproductive pattern exists, with some variations according to position. Ripe gametes reach maximum proportion in March and June, and empty follicles are present in maximum percentage during the reproductive season of May to August. From September to January, reserves accumulate and gametogenesis starts again in February. Thus gametogenesis starts in mid-winter, showing an increase in the proportion of developmental gametes. Reproductive season is from spring to summer, and reserve accumulation takes place in late summer to early winter. This pattern was more pronounced in the lower level of the cultivants in both localities, whereas the middle level of one location had ripe gametes almost all year round. The upper level showed an intermediate pattern. These patterns presumably match micro-environmental differences within the various levels.

Phenotypes of the California mussel, *Mytilus californianus* Conrad (1837)

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The morphological variability of *Mytilus edulis* complex species has been the subject of a great variety of studies. However, the morphological variability of *Mytilus californianus* has not been studied. We found that there are some *M. californianus* without some of the shell characteristics mentioned in the original description of this species. The most remarkable difference was the absence of radial ribs on the exterior of the shell; thus, we tested the presence of at least two phenotypes in *M. californianus*. Six hundred ninety five *M. californianus* of different sizes were collected from the locations La Mina del Fraile, La Bufadora and La Salina in Baja California. For comparison, 58 *M. galloprovincialis* were collected from an aquaculture

facility at Rincón de Ballenas in Bahía de Todos Santos, Baja California. Fourteen morphometric measures and the weight of the shell were measured and a principal component analysis (PCA) and a logistic regression (LR) were carried out to find differences between mussels studied and for obtaining a prediction to assign the phenotypes. The presence of ribs, small ligament margin, a narrow posterior byssal retractor muscle scar and shell weight were the discriminating characters between two groups in *M. californianus* confirming the presence of at least two phenotypes in this species, which were present in all mussel sizes and the studied locations. The LR correctly assigned 99.28% of the shells to each phenotype, and it considered only eight out of the fifteen morphometric measures. The PCA showed a clear morphological difference between both phenotypes of *M. californianus* and *M. galloprovincialis*. The original description of this species by Conrad in 1837 was done taking into account only the phenotype with ribs.

Life history traits and reproductive behavior in *Ariolimax* spp. (Arionidae: Stylommatophora)

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The genus *Ariolimax* includes five described taxa. In addition to the genital characters on which the original descriptions were based, the taxa have been found to differ in life history characteristics and sexual behavior. Egg size does not correlate with growth rate across species, and our data from *Ariolimax columbianus columbianus* are inconsistent with Shibata and Rollo's (1988) finding that within a clutch, growth rate is inversely proportional to egg size. The mean growth rate *A. c. columbianus* (over 16 weeks) is greater than that of either *A. columbianus stramineus* or. *A. dolichophallus*, which have similar growth rates. They also differ in their sexual behavior. In *A. californicus californicus* and *A. dolichophallus* copulation is preceeded by a period of courtship involving reciprocal biting and headswinging which lasts approximately 2 hrs. and may last more than 5 hr. In *A. c. stramineus*, copulation is preceeded by a very brief courtship phase (<20 min) which may involve biting and a few low amplitude head movements. Copulation in *A. c. stramineus* is usually simultaneously reciprocal (3/4) and lasts 1-2 hr. Four instances of heterospecific copulation between *A.c. californicus* and *A. c. stramineus* have been observed so far whereas copulation between *A.c. californicus* and *A. dolichophallus* has only been observed once in several years of observation. Whether fertile offspring are produced in either case is as yet unknown.

Status report on: "Shell-bearing Gastropoda of the Northeastern Pacific"

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The poster with the title "Progress toward completion of taxonomic reference manual: Shell-bearing Gastropoda of the Northeastern Pacific," which accompanies this talk, was prepared a year ago and was shown at WSM and AMS meetings for the year 2002. Text used in the poster provides a broad outline of the project; this same text appears in my current poster abstract. Here I confine myself to an actual report on the progress, now that the funding period from the Packard Foundation is well into its second year. In addition to the poster, the are five binders displayed on tables, showing the text for the two prospective books (northern and southern), and numerous binders containing captions and prints made by Michelle Schwengel, who is my thoroughly talented imaging collaborator supported by the Packard Foundation. The prints have been made by the scanning of my negatives, with adjustments in PhotoShop. The prints are attached to the contact proof print along with a draft copy of the text for the caption and a copy of the museum label for each specimen intended for illustration.

So far (May 2003) there are approximately 3,000 images stored on hard disk, including those for all the new species (of which there are at least 400), plus the images for use in the forthcoming revised edition (J. Carlton, ed.) of "Intertidal Invertebrates of the Central California Coast," and images for the most speciose and taxonomically challenging families, including Fissurellidae, Turbinidae, Trochidae, Muricidae, Buccinidae, and Turridae. Photos have been selected for the Columbellidae and the Fasciolariidae.

I had originally assumed that selection of specimens for illustration would be a rapid process, but instead have found that it is time-consuming because many new photos have to be done in order to show specimens that document the possibilities of variation. There is now a separate voucher collection for the LACM specimens to be figured. What I did not expect (although perhaps I should have) was that this process would continuously bring further new species to my attention, all of which are intended to be described in the book.

In my student days I could not have imagined that so many new species would come to light. In those days I had the impression that the whole fauna had been overnamed and that it was my duty to reduce the number of names. Now I am resurrecting some of the names I had previously thought to be superfluous, but many more of my new species are based on material not available in the older collections, instead based on material resulting from more recent collecting expeditions, including expeditions to the outer coast of Baja California, abyssal material from Oregon, and material recovered during exploratory fishery monitoring in Alaska, including the Aleutian Islands.

I have attempted to update the text for each family during the process of selecting specimens, but have found it difficult to maintain the pace for image selection and updating the text at the same time, so in some cases I have had to settle for improving the state of the outline before

moving to the next family. It is clear, however, that once all the illustrations are on hand, it will be a rapid process to flesh in the outline to turn it into finished text.

The amount awarded by the Packard Foundation was half of what I had asked, so it has been half-time work for Michelle during the two year period for the award. Unfortunately, it has now become apparent that more funding (to bring it to the amount originally requested) will be needed to finish the task of bringing the southern book and subsequently the northern book to a stage ready for publication. All specimens needed for illustration in the southern book have been photographed or are already at hand, which makes it possible for me to move unimpeded; however, I will have to request specimens or images or travel to distant museums to get access to material from the northwestern Pacific required for the second book.

Finally, I have to comment on the dearth of funding for works of this kind. Although there is certainly a market for my efforts and its importance to collectors, resource managers, and those who conduct the many phases of research on marine gastropods, need hardly be mentioned – specific federal funding programs for those with the expertise and museum resources to produce taxonomic manuals remain non-existent. When I was a student, those with an interest in classifications received a modicum of the funding. At this point there is funding only for those purposes for which the thrust is phylogeny, while the working classifications and the production of shell books is considered best left to the advanced amateurs to conduct as commercial ventures. NSF provides funding for collecting in endangered habitats (through its Surveys and Inventories program), and there is money for biodiversity monitoring and for the participants in the endless meetings among those who envision vast databases of the world's biota. Having devoted much of my career, as well as the first two years of my "retirement" toward the successful completion of my objectives, I hardly relish the prospect of again having to worry about funding. However, one way or another, this job will be finished.

To chew or eschew--apophallation in *Ariolimax* as a result of sexual conflict?

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Sexual conflict between mating partners can lead to behavioral strategies where individuals act to manipulate the behavior of their mating partner. The majority of work in this field has focused on gonochoristic animals, those with separate male and female sexes. However, simultaneous hermaphrodites, animals capable of producing both eggs and sperm at the same time, have recently been suggested as being more likely to evolve partner manipulation strategies. Since hermaphrodites are driven to remate through both male and female function, they may be selected to be more promiscuous than gonochroistic females. Greater promiscuity leads to greater sperm competition, as subsequent matings introduce rival sperm. It is therefore thought that partner manipulation tactics that reduce future sperm competition frequently evolve in hermaphrodites.

This study focuses on the unusual mating behavior of penis chewing, termed apophallation, that is observed in some species of Banana slugs. I propose that apophallation serves as an adaptive partner manipulating strategy to reduce sperm competition, and am currently using the

species *Ariolimax dolichophallus* Mead as a study organism to test my predictions. I will be discussing current progress on my work, as well as future directions.

Some families of "prosobranch" Mollusca from Mexico

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Preparation of the catalogue of the non-marine mollusks of México (based on bibliographic sources) has been undertaken. As part of that project three prosobranch families are presented here. Nomenclatural problems were solved; the number of species in the country recorded to date was obtained, followed by the analysis of species distribution. The families treated are: Diplommatinidae (one species), Helicinidae (50 species) and Ceresidae (8 species). The three families are distributed in areas with high humidity (tropical rain forests). Members of Helicinidae also inhabit non-highly seasonal areas (temperature wise) while rainfall is strongly seasonal; vegetation types in that area are tropical deciduous and semideciduous forests. Those families are not distributed in temperate nor dry hot areas with Sonoran or Chihuahuan desert vegetation.

Presence of giant polymorphic cells in *Crassostrea gigas* cultured in Bahía Falsa, Baja California, NW Mexico

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The culture of the Japanese oyster *Crassostrea gigas* is a successful commercial activity in Northwest Mexico. Since 1997 high mortality outbreaks have occurred in the area without apparent reasons. In this study we found gill erosions observed in clinical analysis, inflammation of the tissues at histopathological levels, and in some cases we detected the presence of giant polymorphic cells. In general, conditions mentioned above, including the presence of *Trichodina* sp. and specially the presence of giant polymorphic cells, match with the symptoms of the gill disease caused by an icosahedral DNA virus (GNV infection) first recorded in the Portuguese oyster *Crassostrea angulata* and in the Japanese oyster *C. gigas* in Europe. However, the Transmission Electron Microscopy (TEM) analysis of damaged tissues did not reveal the presence of viral particles.

VI. POSTER SESSION

Beginnings of a new book on the marine bivalve mollusks of Tropical West America

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Research has begun on a monograph covering the marine bivalve mollusks of tropical West America. The manuscript will document and describe all bivalves from the central Pacific coast of Baja California, Mexico, to northern Peru, as well as the offshore islands. It will encompass all habitats from the intertidal zone down to abyssal depths of more than 4,500 meters.

The new monograph will detail approximately 800 species and include color photographs and/or line drawings of each, along with a description of its shell, habitat, and ecology, and references to relevant literature. A particular effort has been made to ensure the book's utility to those outside this geographic area. In this regard, the monograph will contain copiously illustrated keys and character tables at the superfamily level and below.

This volume will be a companion to Coan et al., 2000, which covers the bivalve fauna from arctic Alaska to northern Baja California.

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The History of the Western Society of Malacologists

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Past Historians, Barbara Chaney and Jody Woolsey, present a selection of WSM history scrapbooks from the WSM archives at the Santa Barbara Museum of Natural History. The condition of the early books reflects the lack of knowledge and availability of archival materials that are plentiful today. A conservation project aimed at preserving these for the future is in the planning stages.

Of more immediate concern is a wish to fill in the missing years when there was no historian (or none, at least, that we are aware of). Please make a point to pick up the flyer that will be available at the display, which lists the years in question. Contact information for Jody Woolsey will also be on the flyer if you have photos and/or other memorabilia for any of the years that you can donate or loan for copying.

Shell-bearing Gastropoda of the Northeastern Pacific

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[The poster for which this is the abstract was prepared in July 2002 for WSM and AMS meetings. This is a more detailed abstract than that previously published in program abstracts for those meetings. This is the text used in the poster]

Introduction – Two volumes on shelled gastropods comparable to the highly acclaimed Bivalve Seashells of Western North America, by Coan, Scott and Bernard, published in 2000, are in advanced stages of preparation, to be published by the Natural History Museum of Los Angeles County.

Southern volume – The first volume to be finished treats the species of British Columbia to central Baja California, the area of overlap with the tropical Panamic Province. Species of two faunal provinces are included, those of the subtropical Californian Province and those of the cool-water Oregonian Province. Endemic species from the outer coast of Baja California are included, but the more southern species ranging to Baja California, which were treated by Keen (1971), are excluded.

Northern volume – The second volume treats the more northern species of Arctic Alaska, south to British Columbia and west to the Kurile Islands and Okhotsk Sea, Russia. This provides reasonable geographic limits and emphasizes the faunal distinctions and provincial radiations that distinguish the temperate and cold-water faunas of the northeastern Pacific. Many species occurring in Alaska range west to Russia and northern Japan. Species occurring in the Aleutian Islands tend to have more affinity to the fauna of the Kurile Islands than to the fauna of the Gulf of Alaska.

Previous compilations – Carpenter (1857, 1864) first reviewed the molluscan fauna of the northeastern Pacific. Mollusks of the northeastern Pacific were last fully summarized in checklist form by Dall (1921), followed by Oldroyd (1927), who republished original descriptions and illustrations for the species listed by Dall. Abbott (1974) included all species, but many were only listed.

Treatment of higher categories – All higher category taxa are fully diagnosed. A fully ranked classification is used; problems that arise in comparison with phylogenetic classifications are noted. Type species and manner of designation are given for the genera. References are provided (following the generic synonymy) for recent authors whose generic concepts are similar to my usages.

Species treatment format – Synonymies provide reference to the original description and illustrations for the nominal taxa and synonyms. Type localities and type specimen repositories for nominal taxa and all synonyms, as well as citations of subsequent illustrations of type specimens are included within brackets in the synonymies, providing the essential information for the data-basing purposes of future workers. The text for each species includes a brief

description, comparison to related species, geographic distribution and number of lots in the LACM collection, which provides a measure of relative abundance.

Incorporation of taxonomic advances – Most groups are subjected to major revision, bringing them into conformity with recent taxonomic advances. Some subgenera are raised to full genera to avoid the implication of ancestry implied by traditional usage. However, most monotypic genera are accepted.

Treatment of new species – The format is sufficiently detailed to allow the descriptions and comparisons of approximately 350 new species to be included in the text of the books. Illustrations of radulae and details about paratypes will be provided in an appendix.

Illustrations for the books – Shells are to be illustrated in black and white on a white background, close to the text and with full captions (see sample plate below). Most small specimens are illustrated by macrophotography, which often better conveys surface texture and color patterns than does the use of SEM for shell illustration.

Sources of funding – Although there has long been a demand for the Eastern Pacific gastropod book, and its importance to resource managers and modern systematists is evident, there are no calls for proposals from NSF or other federal agencies for the preparation of taxonomic manuals. This lack of funding is counterproductive, given that an understanding of marine biodiversity is a national goal.

Packard Foundation support – I am pleased to report that the David and Lucile Packard Foundation has provided me with funding for a part-time digital imaging and page-making technician. Michelle Schwengel is now preparing the images from my negatives taken over many years.

Acknowledgments

I am grateful to Daniel Geiger for encouragement and assistance in the early phases of preparation. Ángel Valdés of the LACM is the technical support person, who will assist in editing and will prod me into finishing the books; Lindsey Groves of the LACM keeps up with cataloging and proofing. Michelle Schwengel is skillful with digital imaging; I thank her for the production of this poster. [Poster prepared July 2002]

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VII. REPORTS OF SOCIETY BUSINESS

Executive Board Meetings, 6-10 June 2003

For a variety of logistical and other reasons, and extended discussions regarding finances and membership dues, the Executive Board Meeting was held over the course of several days, in various locations at the Natural History Museum of Los Angeles County. What follows is a summary of these meetings. Participating were: Hans Bertsch, Jorge Cáceres, Douglas J. Eernisse, George L. Kennedy, Christopher Kitting, Edna Naranjo Garcia, Roger R. Seapy, Cynthia Trowbridge, and Ángel Valdés.

Old Business

1. Member payments. Lengthy discussions and multiple proposals regarding on-time or late payments, different categories or levels of membership, etc. The real problem is in members not paying their dues promptly, annually, or even less frequently.

2. Annual Report. In addition to the annual meeting, this is the major benefit of membership in the Society. It also provides a forum for the publication of Extended Abstracts—even encouraging submissions by student members.

3. Resignations and defining of position tasks.

a. Importance of job role clarification. Of particular concern was overlapping and overwhelming tasks on individuals of roles that were appropriate to another position, for instance the Secretary, Treasurer, and Webmaster positions. Dr. Cynthia Trowbridge has served the society exceedingly well as appointed Treasurer, but as she explained, many of her tasks also involved Secretarial tasks. The Society congratulates her for service beyond what she had committed.

b. Cynthia Trowbridge and Terry Arnold resigned their positions (respectively) as Treasurer and Secretary.

New Business

1. Nominating Committee Report

President: Jorge Cáceres

First Vice President: Peter Roopnarine (2005 meeting in San Francisco, CA)

Second Vice President: Roland Anderson (2006 meeting in Seattle, WA, jointly with the American Malacological Society)

Members-at-Large: George Kennedy and Edna Naranjo Garcia (chosen to repeat because of assistance they can provide for the 2004 meeting in Ensenada, Baja California, México)

Treasurer: Steve Lonhart

Secretary: Hans Bertsch

Webmasters: Doug Eernisse and Ángel Valdés

Editor of Annual Report: Doug Eernisse (with valuable assistance by Roger Seapy and other members of the board)

2. Treasurer's Report. Emphasized the need for prompt payment of dues. Reserving conference sites often requires early monetary deposits to guarantee a discounted rate. The report was approved as presented.

3. President's Report. Ángel Valdés thanked Lindsey Groves for helping with the meeting, Kirstie Kaiser for her donation of $200 (U.S.) for the student grant fund, and Christopher Kitting for supplying $400 (U.S.) in funds from the Shore Institute of San Francisco.

4. Vice President's Report. Jorge Cáceres presented and discussed various aspects of the 24-28 June 2004 meeting, including logistics and symposia. He also suggested field/laboratory workshops prior to the meeting as a possible way to increase Society funds. Topics might include: Mollusc Diseases, and Molecular Tools in Malacology.

Respectfully submitted,
Hans Bertsch, Secretary

Annual Business Meeting

The Annual Business Meeting of the Western Society of Malacologists was held in the Education Classroom of the Natural History Museum of Los Angeles County on 10 June 2003, beginning at 16:01 hours.

1. The President, Ángel Valdés, again thanked Lindsey Groves, Kirstie Kaiser, and Christopher Kitting for their assistance and financial contributions.

2. The Treasurer's Report emphasized the problem of collecting dues, and that members should pay in January/February, because conference costs are often due in March.

3. Memberships. Moved and seconded to raise annual dues:

Regular: $20 (U.S.)
Student: $8 (U.S.)

If paid before [15 March] the fees would be reduced:

Regular: $15 (U.S.)
Student: $6 (U.S.)

4. The auction and reprint sale brought in about $720 (U.S.).

5. Nominating Committee. The slate of candidates presented in the minutes of the Executive Board Meeting was unanimously approved.

6. Student Grant Committee consisted of the following members: Lindsey Groves (Chair), Doug Eernisse, Daniel Geiger, Sandra Millen and Peter Roopnarine. Awards were presented to the following students:

a. Diego Zelaya, Museo de la Plata, Departmento Zoología Invertebrados, Buenos Aires, Argentina: "Species of *Thyasira*, *Cyamiocardium*, *Cuspidaria*, and *Benthocardiella* (Bivalvia) in the Magellanic and adjacent sub-Arctic waters." ($800 U.S.)

b. Matthew Clapham, Department of Earth Sciences, University of Southern California, Los Angeles, CA, USA: "The ecological role of modern fauna mollusks in the late Paleozoic." ($600 U.S.)

c. Brooke Miller, Department of Ecology and Evolutionary Biology, University of California, Santa Cruz, CA, USA: "To chew or not to chew: a test of penis gnawing as an adaptive partner manipulating strategy in banana slugs (*Ariolimax dolichophallus* Mead)." ($450 U.S.)

d. Alicia Hermosillo González, Universidad de Guadalajara, Zapopan, Jalisco, México: "Community ecology of the opisthobranch mollusks of Bahía de Banderas, Pacific coast of México." ($350 U.S.)

7. Best Paper Award:

Marta Pola, Departamento de Biología, Facultad de Ciencias del Mar y Ambientales, Universidad de Cádiz, Spain: "The systematics of *Roboastra* Bergh, 1877 (Nudibranchia, Polyceratidae, Nembrothinae)."

Honorable Mention given to Shireen Fahey, California Academy of Sciences, San Francisco, CA, USA: "Phylogeny of *Halgerda* (Mollusca: Gastropoda) contrasting mitochondrial DNA (COI) and morphology."

8. Incoming President Jorge Cáceres gave a spectacular power point presentation on aspects, logistics, field trips, pre-conference workshops, etc., on the 24-28 June 2004 meeting of the Western Society of Malacologists in Ensenada, Baja California, México. He emphasized not

only the scenic grandeur of the city and its locale, but the high caliber of molluscan research being conducted by various institutions.

9. At 17:10 the Transfer of Gavel from 2003 President Ángel Valdés to 2004 President Jorge Cáceres occurred, and with a welcome to Ensenada in June 2004, the 2003 meeting was adjourned.

Respectfully submitted,
Hans Bertsch, Secretary

A Treasurer's Report is not available– The Editor


Western Society
of
Malacologists
2003

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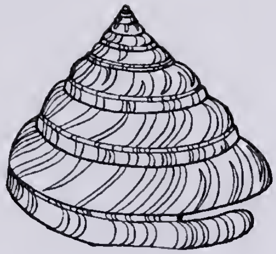

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I. ECOLOGY SESSION
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What larval stages of digeneans can tell us about natural disturbances? (The cercariae of *Cerithidea piculosa* in Celestun, Yucatan before and after the Hurricane Isidore)

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In February 2001, we started a long-term program to study the larval digenean parasites of the horn snail *Cerithidea piculosa* around a water spring in Celestún, Yucatan. In September 2002, Hurricane Isidore hit the Yucatan Peninsula with devastating effects. There are few studies in the literature determining the effect of density-independent factors such as hurricanes upon communities, especially those of parasites or their hosts. Therefore, the aim of this paper was to describe the changes in the snail population density, prevalence, species composition and community structure of the larval stages of digeneans of the horn snail before and after this natural disturbance. Snail population density (snails/m^2), temperature and salinity were recorded monthly from February 2001 to April 2004. Collected snails were transported to the laboratory, measured and dissected to find larval stages of digeneans. The taxonomic identity and prevalence was determined for each digenean species. The maximum number of snails/m^2 before the hurricane was 23 ± 4 in November 2001; the lowest value was 3 ± 1 in September 2002. Five species of digeneans in the cercarial stage were found infecting the snail population: *Renicola* sp. A (prevalence range 1-35), Heterophydae gen. sp. (1-26), *Mesostephanus appendiculatoides* (2-6), *Renicola* sp. B (4-34) and *Euhaplorchis californiensis* (3). The number of species per month was between 1 and 4 before the hurricane. In all cases where snails were infected no double or triple infections were found suggesting that interspecific interactions and predation were processes structuring this parasite community. Immediately after the hurricane, the snail population disappeared until February 2003 with 0.8 ± 1 snails/m^2. Since then, densities have been increasing slowly to reach 14 ± 7 snails/m^2. However, infected snails did not show up until December 2003. In this month, up to 144 snails (1.3%) were infected with the heterophyd cercariae and in April 2004 at least 4 of the 5 digenean species mentioned above have been recorded with prevalences between 1 and 5%. In any case, a double or triple infection has been found, suggesting that interspecific interactions and predation were influencing the parasite community structure. In summary, after the hurricane, the snail population disappeared for 5 months and the digeneans for 1 year and 4 months. However, once they appeared, the same structuring forces seem to be acting upon these parasite communities.

¿Qué nos pueden decir los estadios larvales de digéneos sobre las alteraciones naturales? (la cercaria de *Cerithidea* piculosa en Celestún, Yucatán antes y después del Huracán Isidora)

A partir de febrero del 2001, iniciamos un programa de largo plazo para estudiar los estadios larvales de parásitos digéneos del caracol cuerno *Cerithidea piculosa* alrededor de un cuerpo de agua en Celestún, Yucatán. En septiembre del 2002 el huracán Isidora azotó la Península de Yucatán con efectos devastadores. Hay pocos estudios en la literatura que determinan el efecto de factores denso-independientes como los huracanes, sobre las comunidades, especialmente de parásitos o de sus hospederos. Por consiguiente, el objetivo de este trabajo fue describir tanto los cambios en la densidad de la población de caracol cuerno, como la prevalencia, composición de especies y estructura de la comunidad de los estadios larvales de sus parásitos digéneos antes y después del impacto del huracán Isidora. Entre febrero del 2001 y abril del 2004 se registró mensualmente la densidad poblacional del caracol (caracoles/m^2), así como la temperatura y la salinidad. Los caracoles recolectados fueron transportados al laboratorio, donde se midieron y se disectaron para buscar fases larvales de digéneos. Se calculó la identidad taxonómica y prevalencia para cada especie de digéneo. El número máximo de caracoles/m^2 antes del huracán fue de 23 ± 4 en noviembre del 2001, el valor más bajo fue de 3 ± 1 en septiembre del 2002. Se encontraron 5 especies de digéneos en la fase de cercaria infectando a la población del caracol: *Renicola* sp. A (con un rango de prevalencia de 1-35), Heterophydae gen. sp. (1-26), *Mesostephanus appendiculatoides* (2-6), *Renicola* sp. B (4-34) y *Euhaplorchis californiensis* (3). Antes del huracán el número de especies por mes estaba entre 1 y 4. En todos los casos de caracoles infectados no hubo infecciones dobles o triples, sugiriendo que las interacciones interespecíficas y de depredación fueron procesos que estructuraron a la comunidad de este parásito. Inmediatamente después del huracán, la población del caracol desapareció hasta febrero del 2003 cuando se encontró 0.8 ± 1 caracol/m^2. Desde entonces, las densidades comenzaron a incrementarse paulatinamente hasta alcanzar 14 ± 7 caracoles/m^2. Sin embargo, los caracoles infectados no se observaron hasta dicembre del 2003. En este mes, hasta 144 caracoles (1.3%) se infectaron con cercarias de heterophydos y durante abril del 2004 por lo menos 4 de las 5 especies de digéneos mencionados anteriormente se han registrado con una prevalencia entre 1 y 5%. En todo caso, se han encontrado infecciones dobles o triples, sugiriendo que las interacciones interespecíficas y la depredación influenciaron en la estructura de la comunidad del parásito. En resumen, después del huracán, la población del caracol desapareció por 5 meses y la de digéneos por 1 año y 4 meses. Sin embargo, una vez que ellos aparecieron, las mismas fuerzas estructurales parecen estar actuando sobre las comunidades del parásito.

Shifting baselines in the bivalve assemblage of Mission Bay, San Diego

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Although humans have been impacting local ecosystems for millennia, it is only recently that the most dramatic changes have occurred. While this in itself is not particularly unexpected, what is surprising is the degree to which we fail to account for these past changes. This forgetfulness leads to reduced expectations of what to expect from our natural systems – a phenomenon which has been called the shifting baseline syndrome. This issue of shifting baselines was addressed in San Diego's Mission Bay, which represents one of the most highly modified marine ecosystems on the entire coastline. Starting in the mid-1800's, the bay has seen river diversions, dredging, filling, sand amendments, wetlands destruction, over-harvesting, and pollution. This has resulted in substantial shifts in the system's resident plant and animal communities. This is made evident by examining mollusk populations, for which there is a relatively good source of historical information. Over the last 125 years, the bivalves in the bay have been characterized by a loss of large organisms, changing species assemblages that reflect altered habitat characteristics, and invasion by exotics. Overall, the bivalve community now present in the bay is markedly different from that which existed just 100 years ago, and this will tend to bias our view of "natural" conditions. Such patterns emphasize the need to consider historical conditions and shifting baselines in our efforts to understand, conserve, and restore these valuable last slices of nature in the urban sea.

Cambios de los puntos de referencia móviles (shifting baseline) del agrupamiento de bivalvos de la Bahía Misión, San Diego

Aunque los humanos han impactado los ecosistemas locales durante milenios, los cambios más dramáticos han ocurrido recientemente. Aunque esto es muy común, lo sorprendente es el grado en que nosotros no consideramos estos cambios. Este olvido tiende a reducir las expectativas de lo que esperamos de nuestros sistemas naturales - un fenómeno que se ha llamado el síndrome del cambio de los puntos de referencia móviles (shifting baseline syndrome). Este problema del cambio de los puntos de referencia fue percibido en la Bahía Misión de San Diego, la cual representa uno de los ecosistemas marinos altamente modificados en todo el litoral. A partir de 1800, la bahía comenzó a ser testigo de los cambios ocurridos en el río, tales como, cambios de dirección, dragados, rellenos, cambios en el tipo de arena, destrucción de los pantanos, sobre explotación de especies y contaminación. Esto ha producido cambios sustanciales en las comunidades de plantas y animales que residen en el sistema. Esto es evidente cuando se revisan las poblaciones de moluscos para las cuales hay una fuente relativamente buena de información histórica. Durante los últimos 125 años, los bivalvos en la bahía se han caracterizado por presentar una pérdida de organismos de mayor tamaño, cambios en las agrupaciones de las especies que reflejan características de hábitats alterados e invasión por especies exóticas. En conjunto, la comunidad de bivalvos ahora presente en la bahía es notablemente diferente a la que existió hace 100 años, y esto tenderá a desviar nuestra visión de lo que son las condiciones

"naturales". Tales patrones enfatizan la necesidad de considerar las condiciones históricas y los cambios de los puntos de referencia en un esfuerzo por entender, conservar y restaurar estos últimos y valiosos recursos de la naturaleza inmersos ahora en un océano urbano.

Reproductive cycle of sympatric mussels in Baja California, Mexico

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The bay mussel *Mytilus galloprovincialis* and the California mussel *Mytilus californianus* are sympatric species in the Pacific coast of Baja California, northwest México. To determine the reproductive cycle of both species in a coexistence area, a study of quantitative stereology was performed from January to December 1995. Adults of *M. californianus* and *M. galloprovincialis* were collected from Mina del Fraile (exposed rocky shore) and adults of *M. galloprovincialis* were collected in a culture area (protected area). In both species, spawning organisms were found all year round. The population of *M. galloprovincialis* had one major reproductive season from autumn to early spring in both sites. In late autumn, gonad follicles were full of ripe gametes and developing gametes and some spawning may have occurred. However, the peak of the spawning occurred in early winter. Minor spawning was more frequent in *M. galloprovincialis* from the culture area than from the Mina del Fraile. These differences may be associated with the more stable environmental conditions in the culture area, which also could influence differences in percentage of storage cells from spring to summer. The reproductive season for *M. californianus* lasts from winter to summer. From winter to early summer, gonad follicles were full of ripe gametes and developing gametes and some spawning may have occurred. The reproductive strategy of *M. californianus* is based on an extended reproductive season from winter to summer, while the reproductive season of *M. galloprovincialis* goes from autumn to early spring.

Ciclo reproductivo de especies de mejillón que coexisten en Baja California, México

El mejillón azul *Mytilus galloprovincialis* y el mejillón de California *Mytilus californianus* coexisten en la costa del Pacífico de Baja California, México. Para determiner el ciclo reproductivo de ambas especies en una zona de coexistencia, se realizó un estudio de esterología cuantitativa, entre enero y diciembre de 1995. Mensualmente se recolectaron 30 ejemplares adultos de *M. californianus* y *M. galloprovincialis* en la Mina del Fraile (costa rocosa expuesta) y 30 adultos de *M. galloprovincialis* en una zona de cultivo (área protegida). En ambas especies se encontraron ejemplares en condición reproductiva a lo largo de todo el año. Sin embargo, a nivel poblacional, *M. galloprovincialis* mostró un período reproductivo de invierno a inicios de primavera tanto en la costa rocosa como en la zona de cultivo. A finales de otoño los folículos gonádicos estuvieron llenos de gametos maduros y de gametos en desarrollo y se detectarona algunos desoves. Sin embargo, el desove masivo ocurrió a inicios del invierno. La condición reproductiva fue más frecuente en *M. galloprovincialis* del area de cultivo que en *M.*

galloprovincialis de la zona rocosa. Esas diferencias pueden estar asociadas con las condiciones ambientales, que parecen ser más estables en la zona de cultivo, mismas que también ayudan a explicar las diferencias en el porcentaje de células de almacenamiento durante la primavera y verano. Por el otro lado, los desoves masivos de *M. californianus* ocurrieron en diciembre y de junio a septiembre.

A comparison of the trematode parasites of *Batillaria cumingi* in native (Japan) versus introduced (California) populations

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Invasive species can often alter community structure and stability. Japanese oyster mariculture introduced *Batillaria cumingi* to California. In California salt marshes where *B. cumingi* has successfully invaded, the native horn snail (*Cerithidea californica*) has become less abundant and it has been extirpated in one estuary. The replacement of *C. californica* by *B. cumingi* has also altered the trematode communities in the salt marsh ecosystem. *C. californica* harbors up to 18 different trematode species and is becoming displaced by *B. cumingi* which hosts only 1 nonnative trematode species (*Cercaria batillariae*). These changes led us to investigate the trematode fauna that uses *B. cumingi* as a 1st intermediate host in its native habitat in Japan. Examination of *B. cumingi* populations revealed a positive correlation between prevalence (proportion of infected snails) and latitude ($p<0.05$). Trematode species richness also increases with latitude. These data will be further analyzed and discussed in the context of habitat quality, snail abundance, and the presence of other *Batillaria* and *Cerithidea* species in Japan.

Una comparación del parásito tremátodo de *Batillaria cumingi* en poblaciones nativas (Japón) versus introducidas (California)

Las especies invasivas pueden alterar frecuentemente la estructura y estabilidad de la comunidad. Con la maricultura del ostión japonés se introdujo a *Batillaria cumingi* en California. En las marismas saladas de California donde *B. cumingi* se ha establecido satisfactoriamente, especies nativas como el caracol cuerno (*Cerithidea californica*) ha disminuido en abundancia y ha sido erradicado de un solo estero. El reemplazamiento de *C. californica* por *B. cumingi* también ha alterado las comunidades de trematodos en los ecosistemas de marismas saladas. *C. californica* hospeda a más de 18 diferentes especies de trematodos y están siendo desplazados por *B. cumingi*, el cual hospeda sólo 1 especie de trematodo no nativo (*Cercaria batillariae*). Estos cambios permitieron investigar la fauna de trematodos que utiliza *B. cumingi* como un 1er hospedero intermediario en su habitat nativo en Japón. La revisión de poblaciones de *B. cumingi* revelaron una correlación positiva entre la prevalencia (proporción de caracoles infectados) y la latitud ($p>0.05$). La riqueza de especies de trematodos también se incrementa con la latitud.

Estos datos podrían además ser analizados y discutidos en el contexto de calidad del hábitat, abundancia de caracoles y la presencia de otras especies de *Batillaria* y *Cerithidea* en Japón.

Mass stranding of *Argonauta* spp. (Cephalopoda: Argonautidae) in Bahía de la Paz, Golfo de California, México

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Species of the genus *Argonauta* Linnaeus, 1758 are widespread in tropical areas of the world oceans, but most of the available biological information about them consists of isolated records of their presence in specific localities. This paper describes the mass stranding of 3 species of *Argonauta* (*A. cornuta*, *A. nouryi* and *A. pacifica*) that takes place every year in winter and early spring at Bahía de La Paz, Gulf of California, México (24° N). Data are presented on measurements of 1136 shells of the 3 species that were collected in 1998, 1999, 2000 and 2001. That year, *Argonauta* shells were found at 14 localities in the bay, and at a variety of sites from 23° to 25° N on the east and west shores of the gulf. Shells of *A. cornuta* were the most abundant, whereas the shells of *A. pacifica* were the largest. Annual stranding in the southern Gulf of California are assumed to occur when individuals ascend to the surface to reproduce, are transported to the coast by the wind and water movement, and finally are washed up on beaches at low tide.

Varamientos masivos de *Argonauta* spp. (Cephalopoda: Argonautidae) en Bahía de la Paz, Golfo de California, México

Aunque las especies del género *Argonauta* Linnaeus, 1758 están ampliamente distribuidas en las áreas tropicales de los océanos del mundo, la mayoría de la información biológica disponible sobre ellos consiste de registros aislados de su presencia en localidades específicas. Este trabajo describe varamientos masivos de 3 especies de *Argonauta* (*A. cornuta*, *A. nouryi*. y *A. pacifica*.), que tienen lugar todos los años en invierno y a principios de la primavera en Bahía de La Paz, Golfo de California, México (24° N). Los datos están presentados sobre las mediciones de 1136 conchas de las 3 especies que fueron recolectadas en 1998, 1999, 2000 y 2001. En esos años, se encontraron las conchas de *Argonauta* en 14 localidades en la bahía y en una variedad de sitios, desde 23° a 25° N en las costas del este y oeste del Golfo. Las conchas de *A. cornuta* fueron las más abundantes, mientras que las conchas de *A. pacifica* fueron las más grandes. Se asume que los varamientos anuales en el sur del Golfo de California ocurren cuando los individuos ascienden a la superficie para reproducirse, éstos son transportados a la costa por los vientos y el movimiento del agua y finalmente son depositadas en las playas durante la marea baja.

Comparisons of mollusks and predatory fishes among restored and historical marshes, as evidence of environmental health versus predation pressure by fishes

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Our long-term comparisons of aquatic animals in replicate restored and historical brackish marshes in northern San Francisco Estuary uncovered large, persistent differences among populations found at different marsh sites. Comparisons of abundances of hypothetically major predators (fishes) and the most common benthic prey (often mollusks) among sites may indicate a negative association (as possible prey depletion) or a positive association, as possible indicators of suitable environments for diverse kinds of animals. Maximum gastropod mollusk densities were 100~100,000 hydrobiid snails per m^2, and maximum bivalve densities were ~30 *Macoma balthica* and *Corbicula fluminea* per m^2. These high gastropod densities corresponded to moderate densities of fish mostly mosquitofish, *Gambusia affinis* and voracious gobies, *Tridentiger* spp. Minimum mollusk densities corresponded to minimum fish densities. Maximum fish densities, including native stickleback and sculpins, corresponded to moderate mollusk densities. Among sites, mollusk and fish abundances were positively correlated overall. Additional common animals, including major crustaceans, also were positively correlated with mollusks. Thus, we see no evidence that major fishes are detectably cropping mollusks or other major invertebrates in these marshes, but instead each group of animals is positively correlated among different marshes, each dense assemblage associated with marsh tidal pools on tidal channels and apparently, benthic algae. Transplantings in field bioassays can test for mechanisms accounting for the paucity of virtually all aquatic organisms from marshes without marsh tidal pools along channels.

Comparaciones de moluscos y peces depredadores en los pantanos históricos y restaurados, como una evidencia del medioambiente saludable contra la presión de depredación por peces

Repetidas comparaciones a largo plazo de animales acuáticos en pantanos restaurados e históricos al norte del Estero de San Francisco mostraron diferencias importantes, entre las poblaciones encontradas en los diferentes sitios del pantano. Las comparaciones entre las abundancias de depredadores hipotéticos importantes (peces) con las presas bentónicas más comunes (frecuentemente moluscos) entre diferentes sitios, pueden indicar una asociación negativa (como posiblemente un agotamiento de la presa) o una asociación positiva, como un posible indicador de ambientes adecuados para diversos tipos de animales. Las densidades máximas de moluscos gasterópodos fueron de 100~100,000 caracoles hidrobiidos por m^2, y las densidades máximas de bivalvos fueron ~30 de *Macoma balthica* y de *Corbicula fluminea* por m^2. Estas altas densidades de gasterópodos correspondieron a densidades moderadas de peces, principalmente el pez mosquito, *Gambusia affinis* y los voraces góbidos, *Tridentiger* spp. Las

densidades mínimas de moluscos correspondieron a densidades mínimas de peces Las máximas densidades de peces, incluidos los nativos "pez espinoso" y el "cavilat", correspondieron a densidades moderadas de moluscos. Entre sitios, las abundancias de moluscos y peces fueron correlacionadas positivamente. Otros animales comunes, incluidos los crustáceos, también estuvieron positivamente correlacionados con los moluscos. Por lo tanto, no obtuvimos evidencia de que los peces más importantes consumieran moluscos u otros invertebrados en estos pantanos; sin embargo, cada grupo de animales está positivamente correlacionado entre los diferentes pantanos, cada agrupación está asociada con pozas de marea sobre los canales y al parecer, con algas bentónicas. Los bioensayos de trasplante en el campo, pueden evaluar los mecanismos que contribuyen a dar como resultado la escasez de prácticamente todos los organismos acuáticos en marismas sin posas de mareas a lo largo de los canales.

Trematodes associated with mangrove habitat in Puerto Rican salt marshes

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Snails are commonly infected by trematode parasites. Trematodes can strongly impact the ecological and evolutionary dynamics of snail populations, since they castrate and increase mortality in snail hosts. The distribution of infection by parasites can greatly vary from place to place due to environmental and biological factors. Previous studies have suggested that prevalence of trematode infections on snails should be the highest in habitats that support many final hosts, which are the sources of parasite stages that infect snails. However, some studies have not found this relationship to be very strong. In this paper, we present data that suggest the prevalence of trematodes that parasitize *Batillaria minima* (Prosobranchia: Batillariidae), a common snail in Puerto Rico's shallow coastal lagoons, is related to the distribution of mangroves, which serve as roosting areas for birds. We compared the prevalence of trematode infections on *B. minima* in two different habitats (mudflats vs. mangroves) in two lagoons of Puerto Rico and found a positive relation between the number of infections and mangrove coverage.

Tremátodos asociados con el hábitat de manglares en marismas saladas de Puerto Rico

Los caracoles son comúnmente infectados por parásitos tremátodos. Los tremátodos pueden impactar fuertemente a la dinámica ecológica y evolutiva de las poblaciones de caracoles, ya que ellos limitan las poblaciones e incrementan la mortalidad de los caracoles hospederos. La distribución de la infección por parásitos puede variar grandemente de un sitio a otro debido a factores biológicos y ambientales. Estudios previos han sugerido que la prevalencia de infecciones por tremátodos sobre los caracoles pudiera ser más alta en hábitats donde se presentan muchos hospederos finales, los cuales son la fuente de estadios de parásitos que infectan caracoles. Sin embargo, algunos estudios no han encontrado que estar relación sea tan estrecha. En este trabajo presentamos datos que sugieren que la prevalencia de tremátodos que

parasitan a *Batillaria minima* (Prosobranchia: Batillariidae), un caracol común en las lagunas costeras de Puerto Rico, se relaciona con la distribución de manglares, los cuales sirven como áreas de descanso para aves. Comparamos la prevalencia de infecciones de tremátodos sobre *B. minima* en dos diferentes hábitats, marismas contra manglares en dos lagunas de Puerto Rico y encontramos una relación positiva entre el número de infecciones y la cobertura del manglar.

Using monitoring to study unpredictable, high impact events: effects of human collection of the intertidal limpet *Lottia gigantea*

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Several regionally based multi-investigator coastal research programs have been developed in the last two decades to address large-scale issues such as fisheries management strategies and responses of communities to climate change, and to establish baseline data in case of a large scale perturbation such as an oil spill. These observational schemes may also be useful, when used in a comparative manner, to address localized issues such as the effects of human foraging activities on coastal populations. The Multi-Agency Rocky Intertidal Network (MARINe) is a consortium of 23 state, federal, university and private organizations that conducts intertidal community monitoring biannually at 34 mainland sites and 23 island sites in 6 different counties in Southern California. These sites include legally protected and enforced areas as well as sites with unlimited public access. We use data from 28 MARINe sites to compare the size structure of populations of the intertidal owl limpet *Lottia gigantea*. We find a clear and significant relationship between the median limpet size and the degree of protection from poachers afforded by the sites, with unprotected sites near population centers showing the lowest median size with few large individuals, and protected sites on the Channel Islands showing the largest median size with individuals from all size classes well represented (Fig. 1). Other hypotheses to explain the differences in size structure were rejected. No latitudinal pattern was found in size structure, nor was size structure related to the presence of predatory black oystercatchers (*Haemotopus bachmanii*). Examination of well-protected sites that allow visitation by large school and tourist groups revealed that these sites are rich with large limpets, providing further evidence that surreptitious poaching, rather than visitation to tide pools *per se*, is driving the trend toward smaller size structures. Elimination of large individuals from the population leads to a cascade of events that reduces reproductive output and would possibly depress population densities if not for the contribution of larvae from well protected reserve sites.

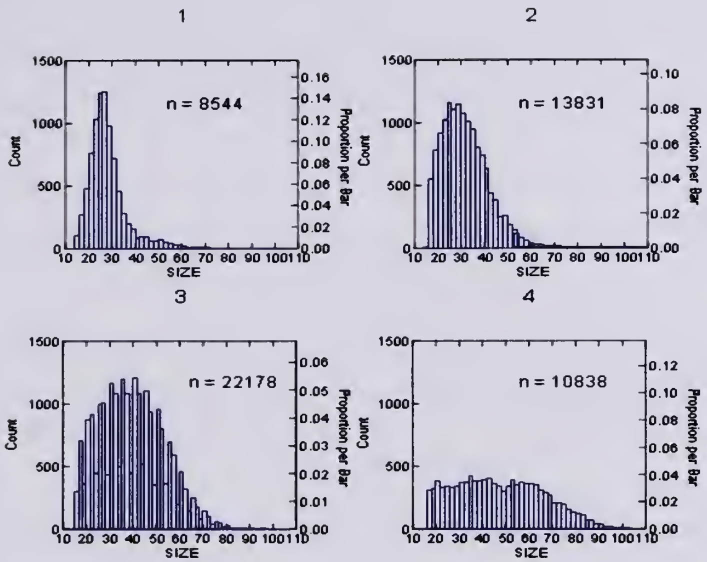

Figure 1 Size frequency histograms for all observations of *Lottia gigantea* between Fall 1996 and Fall 2001 in four accessibility Categories. Category 1: sites where extensive collection is likely because access is not restricted by physical (e.g., gates), geological (e.g., steep cliffs) or enforced legal barriers (e.g., law enforcement patrols, gated communities), and the site is close to densely populated areas. Category 2: sites without enforced collection or visitation restrictions that are nonetheless expected to have lower levels of collection due to difficulty of access or distance from population centers. Category 3: sites with little to no expected collection due to well enforced access and/or collection restrictions and/or extreme difficulty of access. Category 4: sites on the Channel Islands which feature low resident human populations, and in many cases, enforced restrictions against collection and/or extreme difficulty of access.

Uso de monitoreos para estudiar eventos impredecibles de alto impacto: Efectos de la recolecta de la lapa intermareal *Lottia gigantea* por el ser humano

En las últimas dos décadas se han realizado programas interdisciplinarios de investigación costera para atender temas de impacto a gran escala tales como las respuestas de las comunidades al cambio climático, estrategias en el manejo de las pesquerías y para establecer bases de datos como referencia en casos de alteraciones de gran escala como derrames petroleros. Tales esquemas de observación también pueden ser útiles, cuando se usan en términos comparativos, para atender a temas locales tales como los efectos de la recolecta de poblaciones costeras. La Agencia Multiple Rocky Intertidal Network (MARINe) es un consorcio de 23 organizaciones estatales, federales, universitarias y privadas que realizan monitoreos bianuales de la comunidad intermareal en 34 localidades costeras y 23 islas, en 6 condados del

sur de California. Estas localidades incluyen zonas legalmente protegidas así como puntos de acceso público ilimitado. Utilizamos los datos de 28 sitios registrados en el MARINe y comparamos el tamaño y la estructura de las poblaciones de la lapa intermareal *Lottia gigantea*. Encontramos correlaciones significativas entre la talla promedio de las lapas con los sitios monitoreados. Las lapas de menor tamaño promedio se encuentran en sitios no protegidos y cercanos a centros poblacionales. En estos sitios se encontraron pocos ejemplares de tallas grandes. Por otro lado, en los sitios protegidos como las Islas Channel, se encontró que el tamaño promedio de las lapas es mayor y están bien representadas todas las clases de talla.

Preliminary morphometric-biogeographic analysis of the genus *Quoyula* (Gastropoda: Coralliophilidae)

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With the purpose of looking for possible biogeogaphic and morphometric variation, we investigated the morphology of two species of *Quoyula*: *Q. monodonta* and *Q. madreporarum*. We sampled these two species on coral populations in Punta Arena de la Ventana, Baja California Sur (Gulf) and Bahía de Huatulco, Oaxaca (Oaxaca), México. We measured four features of each snail: total length, length of the first spiral, and length and width of the operculum. Specimens were taken by diving, and were removed from corals of the family Pocilloporidae. The proportion of *Quoyula* species in each coral community sampled was highly significant within the locality, being greater for *Q. monodonta*. In reference to the proportion between localities, *Q. monodonta* was significantly greater in the Gulf. In both the Gulf and Oaxaca, there is a clear morphometric separation between the two species. *Quoyula madreporarum* was significant bigger ($P < 0.05$) and more variable ($P < 0.05$) in the Gulf. The results may be considered as initial evidence of the possibility of two distinct species. Morphometric studies, with a greater number of variables, and molecular studies are needed to elucidate if the morphometric variation has a genetic base.

Análisis morfométrico-biogeográfico preeliminar del género *Quoyula* (Gastropoda: Coralliophilidae)

Con el propósito de buscar posibles variaciones biogeográficas y morfométricas, investigamos la morfología de dos especies de *Quoyula*: *Q. monodonta* y *Q. madreporarum*. Muestreamos a estas dos especies sobre poblaciones de coral en Punta Arena de la Ventana, Baja California Sur (Golfo) y Bahía de Huatulco, Oaxaca, México. Medimos cuatro características de cada caracol: longitud total, longitud del primer espiral y longitud y ancho del opérculo. Los especímenes fueron recolectados por buceo y fueron removidos de los corales de la familia Pocilloporidae. La proporción de especies de *Quoyula* en cada comunidad de coral muestreado fue altamente significativa dentro de la localidad, siendo más grande para *Q. monodonta*. En referencia a la

proporción entre localidades, *Q. monodonta* fue significativamente más grande en el Golfo. En ambas zonas estudiadas, el Golfo y Oaxaca, hay una clara separación morfométrica entre las dos especies. *Quoloya madreporarum* se presentó significativamente ($P<0.05$) más grande y más variable en el Golfo. Los resultados pueden ser considerados como evidencia inicial de la posibilidad de que se trata de dos especies distintas. Son necesarios más estudios morfométricos con un mayor número de variables y estudios moleculares, para elucidar si la variación morfométrica inicialmente detectada tiene una base genética.

Ecology of the introduced ribbed mussel (*Geukensia demissa*) in Estero de Punta Banda, Mexico: Interactions with the native cord grass, *Spartina foliosa*

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Introduced populations of *Guekensia demissa* occur on the West Coast of North America. They have been reported in San Francisco Bay, four Southern California wetlands, and in Estero de Punta Banda (EPB), Baja California, Mexico. We randomly sampled benthic invertebrates in four habitat types within EPB: marsh, channel, mudflat and pan. *Geukensia demissa* was the most abundant bivalve in the wetland at EPB. It was significantly associated with the native cordgrass, *Spartina foliosa*, and occurred at higher average densities in vegetated marsh sites (24/ m^2) and *Spartina*-dominated tidal channels (35/ m^2), compared to mudflat (0/ m^2), and pan (0/ m^2) sites. We estimated that the total biomass of this invader was over four times that of the next most abundant bivalve, *Tagelus* sp. in EPB. We examined *G. demissa* for parasites and found that only a few native parasites colonized this introduced host at very low prevalences and intensities. We performed bird surveys to determine the habitat overlap and potential impact of this mussel on the EPB population of light-footed clapper rails (*Rallus longirostrus levipes*), an endangered species in the United States. The high abundance of *G. demissa* in EPB, its presence in clapper rail habitat, and its known effects on salt marsh habitat in its native range, warrant further investigations of the impact of this invader in EPB and elsewhere.

Ecología del mejillón veteado (*Geukensia demissa*) introducido en el Estero de Punta Banda, México: Interacciones con el pasto marino, *Spartina foliosa*

En la Costa oeste de América del Norte, se han establecido poblaciones del mejillón exótico veteado *Geukensia demissa*. Estas se han encontrado en la Bahía de San Francisco, en cuatro zonas pantanosas del sur de California, EUA y en el Estero de Punta Banda (EPB), Baja California, México. Como resultado de un estudio de invertebrados bentónicos realizado en cuatro hábitats dentro del EPB (pantano, canales, marisma y pozas), encontramos que el bivalvo más abundante fue *Geukensia demissa*. Su presencia fue asociada ($p > 0.05$) con el pasto marino nativo, *Spartina foliosa*. Las densidades promedio más altas se registraron en los canales donde domina *S. foliosa* (35/m^2) y en sitios pantanosos con vegetación (24/m^2). No se encontraron en

marisma ($0/m^2$) ni en pozas ($0/m^2$). Estimamos que la biomasa total de este invasor fue cuatro veces mayor que *Tagelus* sp., el segundo bivalvo más abundante en el EPB. Analizamos a *G. demissa* para detectar la presencia de parásitos y encontramos que sólo algunos parásitos nativos, con muy baja prevalencia e intensidad, colonizaron a este hospedero. Realizamos un registro de aves para determinar la sobreposición de hábitat y el impacto potencial de este mejillón sobre la población del ave de marisma, *Rallus longirostrus levipes*, una especie en peligro de extinción en los Estados Unidos. La alta abundancia de *G. demissa* en el EPB y sus efectos conocidos en las marismas, garantizan futuras investigaciones del impacto de este invasor en el EPB y en otras localidades donde se ha establecido.

II. OPISTOBRANCH SESSION
SESIÓN OPISTOBRANQUIOS

Organized by/ Organizado por
Hans Bertsch
California Academy of Sciences, San Francisco

Taxonomic, ecological and zoogeographic revisions to Pacific Coast Nudibranchs (Behrens, 1991)

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The second edition of Pacific Coast Nudibranchs (Behrens, 1991) summarized the taxonomic and biological information on 217 species of opisthobranch molluscs found within the geographic range of the book, from Alaska to Baja California.

Since its printing almost 15 years ago, many new species have been discovered and named, the ranges of known species have been expanded, additional ecological and morphological data have been published, and numerous taxonomic changes at the generic level have occurred. This is a short summary of Behrens, 2004, which updates these data and information. The complete text can be accessed at the following web sites:

http://www.seaslugforum.net/display. and: http://slugsite.us/behrens/dave2004.pdf

The opisthobranch fauna of the Pacific coast of the Americas, from the Alaskan Bering Strait to Baja California's tip at Cabo San Lucas (hence including records from three countries: United States, Canada, and Mexico), now totals 252 species.

Some of the species that were not in the 1991 book include the shelled cephalaspideans *Cylichna diegensis*, *Acteocina eximia, Retusa zystrum, Volvulella californica*, *Volvulella panamica, Philine aperta, Bathydoris aioca*, *Diaulula greeleyi* and others.

Bathydoris aioca was originally described from northeast of Isla Guadalupe, Baja California, based on a single specimen collected in 1960. James Lance published a short manuscript in 1967 reporting the finding of this holotype specimen. Valdés and Bertsch (2000) reported on a series of specimens collected off the Oregon coast, from 1963-1965, providing further

anatomical descriptions of this deep water species (it is known from about 2700-2850 meters depth), as well as a significant range extension.

The Nayarit, Mexico, species *Peltodoris nayarita* Ortea & Llera, 1981, is a synonym of *Diaulula greeleyi* (MacFarland, 1905), originally named from Brazil.

The second half of Behrens, 2004, is titled "New Information and Nomenclatural Changes." It includes range extensions, ecological data, and generic changes.

For instance, the southern California species *Navanax inermis* has now been reported from Bolinas Lagoon in Marin County, northern California.

The southernmost range of *Berthella californica* had previously been from the Islas Coronados, right next to the U.S./Mexican border. Its range is now extended to the Islas Galápagos.

The range of *Aegires albopunctatus* is extended north from British Columbia to Ketchikan, Alaska.

Polycera tricolor is reported from Ketchikan, Alaska; previously its northernmost occurrence had been in British Columbia.

Tritonia myrakeenae, originally known from Santa Barbara, California, to Isla Cedros, Baja California, has since been reported from Costa Rica.

Babakina festiva had been known from Marin County, California, to Nayarit, Mexico, along our coastline. It was also originally reported from Japan, and has since been reported as possibly occurring in Spain and New Zealand. Another range extension reported is its collection from the Bahamas, in the western Atlantic.

The so-called "yellow-gilled porostome" *Doriopsilla gemela* has a distinctive, nearly flattened egg mass with large lecithotrophic eggs, rather than the typical upright circular ribbon with small eggs laid by other members of its genus and most other dorids. The life history and ecology of *Doriopsilla gemela* in Bahía de los Ángeles were reported by Bertsch (2002), based on over 10 years of study in that Sea of Cortez location. The species almost always occurs on the pink sponge *Pseudosuberites pseudos* and the yellow sponge *Cliona celata*. It has a definite annual cycle, with the new generation appearing in the early fall.

Some of the many generic changes that Behrens, 2004, reports include the following: *Hopkinsia rosacea* is now in the genus *Okenia*. *Laila cockerelli* has been transferred to the genus *Limacia* which holds priority by date of publication. *Tambja fusca* is the junior synonym of *Tambja abdere*, by reason of page priority. *Anisodoris nobilis* has been transferred to the genus *Peltodoris* based on anatomical data examined and described by Valdés (2002).

There are a number of Panamic (tropical west America) province species that have now been reported from southern California. The outer coast of Baja California between Bahía Magdalena and Punta Eugenia is a provincial-level ecotonal transition region (Bertsch, 1993). Southern tropical species are well expected to occur within this region, as are northern temperate species. But for the tropical species to extend farther north is a definite exception (as the reverse also holds).

Behrens (2004) reports that the following truly tropical Panamic species have been reported to occur in southern California waters: *Tritonia pickensi*, *Flabellina bertschi*, *Polycera alabe*, *Chromodoris galexorum* and *Aplysia parvula*.

It is probably important to contrast the frequency and timing of their occurrences in the tropical Panamic province waters with those occurrences in the temperate southern California provincial waters. Seasonality and timing associated with El Niño events will then be quite obvious. So these may not really be "range extensions," but most likely climatically influenced

periodic northerly distributions. These data are important to our understanding of marine biodiversity.

A concluding comment which is very important to our understanding of the distribution and life histories of marine invertebrates: When we talk about the range or distribution of an organism, we should not just say it occurs from south point X to north point Y. We need to explain clearly where the majority of the specimens have been found. We need to discuss why species from one zoogeographic province are found in another. Currents move many larvae, but given water temperature variations, these may not survive. But at certain times, they do, and we have a range extension of a tropical species into the cooler temperate waters.

Precise data are needed to really understand the biodiversity and biogeography of marine animals. For example, nearly every specimen of bird is reported to an international data base, so their seasonality, rareness, or "exceptions" (you know, the bird everyone flies thousands of miles to see or photograph, because it has never before been seen in Texas), are well noted. Every year, the Audubon Society sponsors a "bird count." We need a similar effort for marine invertebrates. Definitely there are enough scuba divers who love nudibranchs that this could be a real possibility. Maybe even twice-a-year surveys—to try to understand some of the seasonal variation.

[Note added during Annual Report publication preparation (2007): Three recent books (Behrens & Hermosillo, 2005, Camacho-García, Gosliner & Valdés, 2005, and Hermosillo, Behrens & Ríos Jara, 2006; see review and discussion by Bertsch, 2007) incorporate and update these changes.]

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Revisiones taxonómicas, ecológicas y zoogeográficas a Pacific Coast Nudibranchs (Behrens, 1991)

La segunda edición de Pacific Coast Nudibranchs (Behrens, 1991) reunía información taxonómica y biológica de 217 especies de moluscos opistobranquios dentro del rango geográfico del libro, desde Alaska hasta Baja California.

Desde su impresión hace 15 años, se han descubierto y nombrado muchas especies nuevas, se han ampliado los rangos de especies conocidas, se han publicado datos morfológicos y ecológicos adicionales y ha habido numerosos cambios taxonómicos a nivel género.

Este es un breve sumario de Behrens, 2004, que actualiza dicha información y datos. El texto completo se puede encontrar en los siguientes sitios web:

http://www.seaslugforum.net/display.cfm?base=brbehre1&id=12698
http://slugsite.us/behrens/dave2004.pdf

Ahora son 252 especies en la fauna opistobranquia de la costa Pacífico Americano, desde el estrecho de Bering en Alaska, hasta la punta de Baja California en Cabo San Lucas (que incluye registros de tres países: Estados Unidos, Canadá y México).

Algunas de las especies que no incluía el libro de 1991 son los cefalaspídeos con concha *Cylichna diegensis*, *Acteocina eximia, Retusa zystrum, Volvulella californica*, *Volvulella panamica, Philine aperta, Bathydoris aioca*, *Diaulula greeleyi* y otros.

Bathydoris aioca fue descrita originalmente del noreste de Isla Guadalupe, Baja California, con base en un solo espécimen colectado en 1960. James Lance publicó un breve manuscrito en 1967 en que reporta el hallazgo de este espécimen holotípico. Valdés y Bertsch (2000) reportaron sobre una serie de especímenes colectados en la costa de Oregon entre 1963 y 1965, y proporcionan descripciones anatómicas adicionales sobre esta especie de aguas profundas (de 2,700 a 2,850 metros), así como una significativa extensión de rango.

La especie de Nayarit, México, *Peltodoris nayarita,* Ortea & Llera, 1981, es sinónima de la *Diaulula greeleyi* (MacFarland, 1905), originalmente nombrada del Brasil.

La segunda parte de Behrens, 2004, se titula "Nueva Información y Cambios en Nomenclatura." Incluye extensiones de rango, datos ecológicos y cambios genéricos.

Por ejemplo, la especie *Navanax inermis* del sur de California, ahora ha sido reportada desde

Bolinas Lagoon en Marin County, en el norte de California.

Previamente, el rango más austral para *Berthella californica* era desde las Islas Coronados, junto a la frontera México/E.U. Ahora su rango se extiende hasta las Islas Galápagos.

El rango para *Aegires albopunctatus* se extiende al norte de la Columbia Británica hasta Ketchikan, Alaska.

Polycera tricolor se reporta en Ketchikan, Alaska; previamente, su ocurrencia más septentrional era la Columbia Británica.

Tritonia myrakeenae, que originalmente se conocía desde Santa Bárbara, California, hasta Isla Cedros, Baja California, ha sido reportada en Costa Rica.

Babakina festiva se conocía desde Marin County, California, hasta Nayarit, México, por toda nuestra costa. También fue reportada originalmente desde Japón, y desde entonces se ha reportado que ocurre posiblemente en España y en Nueva Zelanda. Otra extensión de rango reportado es que se ha colectado en las Bahamas, en el Atlántico oeste.

La llamada "porostoma de branquia amarilla", *Doriopsilla gemela*, tiene una masa de huevos casi aplanada, con grandes huevos lecitotróficos, en vez del típico listón vertical enrollado con huevos pequeños, como los de otros miembros de su género y la mayoría de los dóridos. Bertsch (2002) reportó la vida natural y ecología de la *Doriopsilla gemela* en Bahía de los Ángeles, basándose en más de 10 años de estudio en ese sitio del Mar de Cortés. La especie casi siempre ocurre sobre la esponja rosa *Pseudosuberites pseudos* y la esponja amarilla *Cliona celata*. Tiene un ciclo anual definido, cuya nueva generación aparece a principios del otoño.

Los siguientes son algunos de los muchos cambios genéricos que reporta Behrens, 2004: *Hopkinsia rosacea* ahora está en el género *Okenia*. *Laila cockerelli* se transfiere al género *Limacia,* que tiene prioridad por fecha de publicación. *Tambja fusca* es sinónima menor de *Tambja abdere*, en razón de prioridad de página. *Anisodoris nobilis* ha sido transferida al género *Peltodoris*, con base en datos anatómicos que examinó y describió Valdés (2002).

Hay varias especies provinciales Panámicas (oeste tropical Americano) que ahora se han reportado en el sur de California. La costa exterior de Baja California, entre Bahía Magdalena y Punta Eugenia, es una región de transición ecotonal a nivel provincial (Bertsch, 1993). Dentro de esta zona, bien puede esperarse que ocurran especies tropicales del sur, así como especies del norte templado. Pero sería una clara excepción que especies tropicales se extendiesen más al norte (lo mismo aplica a la inversa).

Behrens (2004) reporta que las especies realmente Panámicas tropicales cuya ocurrencia se ha reportado en aguas sudcalifornianas, son las siguientes: *Tritonia pickensi*, *Flabellina bertschi*, *Polycera alabe*, *Chromodoris galexorum* y *Aplysia parvula*.

Sería importante poder contrastar frecuencia y temporalidad de ocurrencia en aguas provinciales Panámicas tropicales, con la ocurrencia en aguas provinciales templadas del sur de California. La estacionalidad y temporalidad asociada a eventos de El Niño sería entonces bastante obvia. Así que no serían realmente "extensiones de rango", sino más bien distribuciones periódicas hacia el norte influenciadas climáticamente. Estos datos son importantes para nuestro conocimiento de la biodiversidad marina.

Para concluir, un comentario muy importante para nuestra comprensión de la distribución y vida natural de los invertebrados marinos: Cuando hablamos del rango o distribución de un organismo, no basta con sólo decir que ocurre desde el punto X del sur, al punto Y del norte. Necesitamos explicar claramente el sitio donde se ha encontrado la mayoría de los especímenes. Necesitamos discutir porqué las especies de una provincia zoogeográfica se encuentran en otra. Las corrientes mueven muchas larvas, pero podrían no sobrevivir dadas las variaciones de

temperatura del agua. Pero ciertas veces sí sobreviven y así tenemos una extensión del rango de especies tropicales hacia aguas templadas más frías.

Se requieren datos precisos para entender realmente la biodiversidad y biogeografía de los animales marinos. Por ejemplo, casi todos los especímenes de aves se reportan a una base de datos internacional para llevar un buen registro de su estacionalidad, rareza o "excepciones" (ustedes saben, ese cierto pájaro por el que todos viajan miles de kilómetros para verlo o fotografiarlo porque nunca antes se había visto en Texas). Cada año la Audubon Society patrocina un "conteo de aves". Necesitamos hacer un esfuerzo similar para los invertebrados marinos. Definitivamente hay suficientes buzos amantes de los nudibranquios como para hacer de esto una realidad. Quizás hasta llevar a cabo levantamientos dos veces por año para tratar de entender las variaciones estacionales.

[Nota agregada durante la preparación del Reporte Anual (2007): Hay tres libros recientes que incorporan y actualizan estos datos: Behrens & Hermosillo, 2005, Camacho-García, Gosliner & Valdés, 2005, y Hermosillo, Behrens & Ríos Jara, 2006; véanse comentarios en Bertsch, 2007).]

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Opisthobranch fauna of Bahía de Banderas, México (tropical eastern Pacific)

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Bahía de Banderas is located on the west coast of México, in the states of Jalisco and Nayarit. This bay is the largest on Mexico´s mainland. It is over 1,000 km^2 and has 115 km of coastline, two major islands and numerous islets, rocks and sea mounts. Bahía de Banderas is characterized by complex hydrography and oceanography since it is the convergence point of three major current systems. The mean surface temperature is 26.4ºC, varying from 20ºC in April to 30ºC in September. Its varied temperatures, hydrography and great size contribute to Bahía de Banderas´ unique composition of opisthobranch fauna. Few reports have been published on the opisthobranch fauna of the northern coast of the Bay, in Nayarit. However, no reports have been published on the opisthobranch fauna of the central and southern sections of the Bay, along the coast of Jalisco. The goal of this work was to learn more about the opisthobranch fauna of Bahía de Banderas using SCUBA and intertidal collecting methods. The first 12 months, 30 sites that represent the habitats within the bay were visited randomly during various occasions. A species list was compiled. I selected the 10 sites with highest species richness, Shannon diversity index, abundance and representation of habitat. Since March 2003, surveys have been performed once a month to determine species presence and seasonality. Preliminary analyses of distribution and seasonality are presented in this work for some of the most abundant species in Bahía de Banderas: *Tambja abdere* Farmer, 1978, *Lomanotus vermiformis* Eliot, 1908, *Hypselodoris agassizii* (Bergh, 1894) and an undescribed *Flabellina* sp. Natural history and biogeography of these four species are reviewed.

Fauna de Opistobranquios de Bahía de Banderas, México (Pacifico este tropical)

Bahía de Banderas está localizada en la costa oeste de México, en los estados de Jalisco y Nayarit. Esta bahía es una de las más grandes de México con más de 1,000 km^2 y con 115 Km. de línea de costa. Cuenta con dos islas principales, numerosos islotes, rocas y montañas marinas. Bahía de Banderas se caracteriza por una hidrografía y oceanografía complejas, ya que es el punto de convergencia de tres sistemas de corrientes marinas. La temperatura superficial media es de 26.4 ºC y varía de 20 ºC en abril a 30 ºC en septiembre. Su variedad de temperaturas, hidrografía y gran tamaño contribuyen a que su composición faunística de opistobranquios sea única. Se han publicado algunas referencias sobre la fauna de opistobranquios de la costa norte de la Bahía en Nayarit. Sin embargo, no se han publicado registros sobre la fauna de opistobranquios de las zonas centro y sur de Bahía de Banderas, a lo largo de la costa de Jalisco. El objetivo de este trabajo fue el de aprender más acerca de la fauna de opistobranquios de la Bahía, utilizando inmersiones con equipo de buceo y métodos de recolecta en la zona intermareal. Durante los primeros 12 meses se visitaron aleatoriamente 30 sitios de muestreo que representaban los hábitats propios de la Bahía. Se compiló una lista de especies y se seleccionaron los 10 sitios con base en la mayor riqueza de especies, por el índice de diversidad Shannon, la abundancia y representatividad del hábitat. Desde marzo de 2003 se han llevado a cabo valoraciones mensuales, para determinar la presencia de especies y su estacionalidad. Los análisis preeliminares de distribución y estacionalidad se presentan en este trabajo, para algunas de las especies más abundantes en Bahía de Banderas: *Tambja abdere* Farmer, 1978, *Lomanotus vermiformis* Eliot, 1908, *Hypselodoris agassizii* (Bergh, 1894) y una especie no descrita del género *Flabellina*. Se hace una revisión de la historia natural y biogeografía de esas cuatro especies.

A new species of *Marionia* from the Indo-Pacific region (Mollusca: Nudibranchia)

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Collections in the Philippines during 1992, 1994, and 1995, along with specimens from Indonesia collected during 1998, provide the basis for the description of a new species of tritoniid nudibranch. When the photographs of the animals were first examined, it was thought they represented two distinct species due to differences in color and pattern. However, careful examination did not reveal discernable differences in the external morphology or anatomy and characteristics of the reproductive and digestive organs. *Marionia* species "a" does not match any published descriptions of Indo-Pacific tritoniids, and is described herein. These animals have been recorded at depths of 6.1 to 22.9 m, with a maximum-recorded size of 60 mm alive. The animals have a pale green or yellow background color, with a pattern of dark red-brown lines or reticulations on the notum, a medial dorsal strip which is lighter in color and less distinctly

patterned, and transverse strips between the paired branchial plumes which are similarly lighter in color and pattern. The notal margin extends out over the sides of the body, and from it are produced 10 pairs of branchial plumes, and the unornamented sheaths of the rhinophores. The branchial plumes and the pinnate processes of the rhinophores are a darker red or green color, and the tips of the rhinophores are white. The oral veil contains 4 pairs of papillae, the innermost shortest and simple, the outermost being grooved oral tentacles, and the ones between usually with bifid apices. Most of the velar papillae are tipped with white. External genitalia are on the right side, between the second and third branchial plume. The anus and nephroproct are also on the right side, below the fourth branchial plume. Buccal armature includes a jaw with a single row of denticles giving a serrate appearance, and a radula with a tricuspid rachidian exhibiting distinctive folding, differentiated first lateral teeth, and hammate outer laterals. Cuticular plates are present in the stomach. Stomach contents reveal that one of the Philippine animals is feeding on octocorals of the family Ellisellidae (Gray, 1859). This is the second record of a nudibranch feeding on this family of octocoral. A new character of the reproductive system (a bilobed bursa copulatrix) is recorded for the first time.

Una nueva especie de *Marionia* de la región del Indopacífico (Mollusca: Nudibranchia)

Ejemplares recolectados en las Filipinas en los años 1992, 1994, y 1995, junto con especímenes de Indonesia recolectados en 1998, sustentan la base para la descripción de una nueva especie de un nudibranquio tritónido. Cuando se hicieron los primeros análisis de las fotografías tomadas a estos animales, se pensó que se trataban de dos especies distintas por sus diferencias en coloración y patrón característico. Sin embargo, el examen detallado no mostró diferencias aparentes en la morfología externa o anatomía y en las características de los órganos reproductivos y digestivos. La especie *Marionia* 'a' no concuerda con ninguna descripción publicada de tritónidos del Indopacífico y se describe en este trabajo. Estos animales se han encontrado a profundidades de 6.1 a 22.9 m, con una talla máxima de 60 mm en ejemplares vivos. Los animales son verde pálido o amarillos, con un patrón de líneas de un café rojizo oscuro o reticulaciones sobre el notum, una banda media dorsal de un color claro y con un patrón menos distintivo, y bandas transversales entre las plumas branquiales pareadas, las cuales son ligeramente similares en color y patrón. El margen notal se extiende hacia afuera sobre los lados del cuerpo y de ahí surgen 10 pares de plumas branquiales y las hojas no ornamentadas de los rinóforos. Las plumas branquiales y los procesos pinados de los rinóforos son rojo obscuro o verdes, y las puntas de los rinóforos son blancas. El velo oral contiene 4 pares de papilas, la más interna corta y simple, la externa con tentáculos orales acanalados y la de en medio usualmente con ápices bífidos. La mayor parte de la papila velar esta moteada de blanco. Los genitales externos están en el lado derecho, entre la segunda y tercer pluma branquial. El ano y el nefroprocto están también en el lado derecho, por debajo de la cuarta pluma branquial. La armadura bucal incluye una mandíbula con una línea simple de dentículos dando una apariencia aserrada, y una rádula con forma tricúspide mostrando pliegues distintivos, diferenciando el primer diente lateral y laterales externos armados. Se presentan placas cuticulares en el estómago. El contenido estomacal de un animal de las Filipinas reveló que se alimenta de octocorales de la familia Ellisellidae (Gray, 1859). Este es el segundo registro de un nudibranquio que se alimenta de esta familia de octocorales. Se observó por primera vez un nuevo caracter del sistema reproductivo (una bursa copulatrix bilobulada).

Two new species of dorid nudibranchs (Mollusca, Opisthobranchia) from the Mar de Cortés, Baja California, México

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Bahía de Los Ángeles (BLA) has an intriguing and contrasting biota. Because of the rain shadow effect that blocks most rainfall from the Pacific Ocean, the terrestrial habitat is excruciatingly barren and depauperate. However, because of upwelling caused by currents and tidal flow between Isla Ángel de la Guarda and the peninsula, the marine environment is faunistically rich: the spring benthic algal bloom carpets the bottom and extends into the water column; numerous marine birds nest and breed on the islands; over 10 species of cetaceans are known from the region; and the magnificent filter-feeding whale shark, *Rhincodon typus*, seasonally appears in the bay and its environs. The bay is located about 600 km south of the U.S.-Mexican border (29° N; 113° 32' W). Inside the bay are a number of islands that provide distinct habitats for marine organisms and roosting sites for marine birds. The nudibranch fauna is remarkably rich. The type localities of ten species are in the BLA area. *Okenia angelensis* Lance, 1966, was named from the "lowest intertidal zone, BLA." *Cerberilla pugnoarena* Collier & Farmer, 1964, and *Eubranchus cucullus* Behrens, 1985, were named from Puerto Refugio, Isla Ángel de la Guarda. *Cuthona longi* Behrens, 1985, was named from Isla Raza, and *Dendrodoris stohleri* Millen & Bertsch, 2005, from Punta la Herradura. Five species cite Punta la Gringa (about 10 km north of town) as their type locality: *Bajaeolis bertschi* Gosliner & Behrens, 1986; *Polycerella glandulosa* Behrens & Gosliner, 1988; *Trapania goslineri* Millen & Bertsch, 2000; *Peltodoris lancei* Millen, in Millen & Bertsch, 2000; and *Okenia angelica* Gosliner & Bertsch, 2005. During the last 20 + years, HB has been performing regular research on the opisthobranchs at Punta la Gringa. In addition to new species, these studies have yielded information about the biogeography and distribution, community structure, ecology and natural history of these gastropod mollusks. In this presentation, we will give a preliminary description of two new species (one each from the genera *Diaulula* and *Peltodoris*) that were collected by HB at Punta la Gringa. Of special note, is that these new species are so different from known species within these genera, that even though only one specimen of each has been seen, they are obviously distinct, and warrant designation as new species.

Dos especies nuevas de nudibranquios dóridos (Mollusca, Opisthobranchia) del Mar de Cortés, Baja California, México

Bahía de Los Ángeles (BLA) posee una biota intrigante y contrastante. Debido al efecto de sombra que impide la mayoría de las lluvias del Océano Pacífico, el hábitat terrestre es extremadamente árido y paupérrimo. Sin embargo, debido a las surgencias causadas por las corrientes y el régimen mareal entre Isla Ángel de la Guarda y la península, el ambiente marino es faunísticamente rico: las afloraciones de algas bentónicas en primavera cubren el fondo y se

extienden hacia la columna de agua; numerosas aves marinas anidan y se aparean en las islas; más de 10 especies de cetáceos se conocen en la región y el majestuoso tiburón ballena, *Rhincodon typus*, aparece estacionalmente en la bahía y sus alrededores. La bahía está localizada a unos 600 Km. al sur de la frontera de México con los Estados Unidos (29°E N; 113° 32' O). Dentro de la bahía hay varias islas que proveen hábitats distintos para los organismos marinos y lugar de descanso para las aves marinas. La fauna de nudibranquios es particularmente rica. Las localidades tipo para diez especies están en el área de BLA. *Okenia angelensis* Lance, 1966, fue nombrada como "de la zona intermareal baja, de BLA". *Cerberilla pugnoarena* Collier & Farmer, 1964 y *Eubranchus cucullus* Behrens, 1985, fueron nombradas para Puerto Refugio, Isla Ángel de la Guarda. *Cuthona longi* Behrens, 1985, fue nombrada desde Isla Raza, y *Dendrodoris stohleri* Millen & Bertsch, 2005, desde Punta la Herradura. Cinco especies se refieren a Punta la Gringa (aproximadamente a 10 Km. al norte de la ciudad) como su localidad tipo: *Bajaeolis bertschi* Gosliner & Behrens, 1986; *Polycerella glandulosa* Behrens & Gosliner, 1988; *Trapania goslineri* Millen & Bertsch, 2000; *Peltodoris lancei* Millen en Millen & Bertsch, 2000; y *Okenia angelica* Gosliner & Bertsch, 2004. Durante más de 20 años, el co-autor HB ha llevado a cabo investigaciones sobre opistobranquios en Punta la Gringa. Además de dos nuevas especies, esos estudios han brindado información acerca de la biogeografía y distribución, la estructura de la comunidad, la ecología y la historia natural de esos moluscos gasterópodos. En esta presentación, daremos una descripción preeliminar de las dos nuevas especies (una de ellas del género *Diaulula* y otra del género *Peltodoris*) que fueron recolectadas por HB en Punta la Gringa. Cabe destacar, que esas especies nuevas son muy diferentes de las conocidas dentro de esos géneros y que aún y cuando sólo un espécimen de cada una de ellas ha sido encontrado, evidentemente se tratan de especies distintas, lo que garantiza esta designación.

III. PHYLOGENETICS SESSION
SESIÓN FILOGENÉTICA

Organized by/ Organizado por
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Revival of the genus *Cyanoplax* Pilsbry, 1892, for a clade of west coast chitons

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Before Kaas and Van Belle (1981: Zool. Verh. 185: 1-43) and Ferreira (1982: Veliger 25: 93-138) concluded that *Cyanoplax* Pilsbry, 1892 (type species: *Chiton hartwegii* Carpenter, 1855) was a junior synonym of *Lepidochitona* Gray, 1821 (type species: *Chiton cinereus* Linnaeus, 1767), most treatments of West Coast chitons had used *Cyanoplax* for an assemblage of small chitons with rather unremarkable shell and girdle features. West coast members of this genus do show considerable interesting variation in their parental care (free spawning vs.

brooding) and sexual reproduction (separate sexes vs. simultaneous hermaphrodites with self-fertilization). My own studies contrasting reproductive patterns between these species (Eernisse, 1988: Biol. Bull. 174: 287-302) were somewhat limited because the phylogenetic relationships among the seven studied *Lepidochitona* spp. were only partly resolved and because the other worldwide members of *Lepidochitona* were not included. In order to address these limitations, I have sequenced two mitochondrial gene regions for representatives of all of the available West Coast members of *Lepidochitona*, selected Atlantic/Mediterranean/Caribbean members of this genus, and a diversity of outgroup species. The results clearly indicate that the West Coast species that have been included in this genus are not at all closely related to a monophyletic grouping of *Lepidochitona* species sampled from the northern Atlantic and Mediterranean Sea. The latter should retain the genus name because it includes the type species for the genus, *L. cinerea*. The West Coast species are a completely separate monophyletic lineage, here provisionally referred to once again as *Cyanoplax* Pilsbry, 1892. Preliminary evidence indicates that the sister taxon of *Cyanoplax* is comprised of *Nuttallina* spp. (itself monophyletic) plus *L. beanii* from the Gulf of California, *L. liozonis* from the Caribbean, and *L. turtoni* from South Africa. *Dendrochiton* Berry, 1911, which Kaas and Van Belle have considered to be a subgenus of *Lepidochitona*, has instead been resolved as sister taxon of *Mopalia* Gray, 1847, and this makes some sense because the members of *Dendrochiton* and *Mopalia* resemble each other in bearing setiose hairs on their girdle. *Tonicella* Carpenter, 1873, which Kaas and Van Belle have considered to be in the same subfamily as *Lepidochitona*, instead appears to have closer affinities to other members of a mostly northern Pacific clade that includes *Mopalia*, *Dendrochiton,* and *Cryptochiton* Middendorff, 1847. This improved resolution for *Cyanoplax* spp. has made it possible to study the evolution of reproductive traits such as brooding and hermaphroditism within the genus.

Reestablecimiento del género *Cyanoplax* Pilsbry, 1892, para un clado de quitones de la costa oeste

Antes de Kaas y Van Belle (1981: Zool. Verh. 185: 1-43) y Ferreira (1982: Veliger 25: 93-138) se concluyó que *Cyanoplax* Pilsbry, 1892 (especie tipo: *Chiton hartwegii* Carpenter, 1855) era un sinónimo de *Lepidochitona* Gray, 1821 (especie tipo *Chiton cinereus* Linnaeus, 1767). En la mayoría de los compendios sobre quitones de la costa Oeste han utilizado el género *Cyanoplax* para agrupar a pequeños quitones con una concha no remarcada y con rasgos acintados. Los miembros de la costa Oeste de este género muestran una considerable variación respecto al cuidado parental (desoves libres vs. crianza) y a su reproducción sexual (sexos separados vs. hermafroditas simultáneos con auto fertilización). Mis propios estudios contrastando los patrones reproductivos entre esas especies (Eernisse, 1988: Biol. Bull. 174: 287-302) han sido algo limitados debido a que las relaciones filogenéticas entre las siete especies de *Lepidochitona* estudiadas sólo fueron resueltas parcialmente y porque los otros miembros de *Lepidochitona* de otras partes del mundo no se incluyeron. Para resolver estas limitantes, he secuenciado dos regiones del gen mitocondrial con representantes de todos los miembros disponibles de *Lepidochitona* en la Costa Oeste, representantes seleccionados de este género del Atlántico – Mediterráneo – Caribe y una diversidad de especies fuera del grupo. Los resultados indican claramente que las especies de la Costa Oeste que han sido incluidas en este género, no están del todo cercanamente relacionadas con una agrupación monofilética de las especies de *Lepidochitona* muestreadas en el norte del Atlántico y mar Mediterráneo. El último debiera

conservar el nombre genérico debido a que incluye a la especie tipo del género, *L. cinerea*. Las especies de la Costa Oeste constituyen un linaje monofilético completamente separado, que aquí referiremos provisionalmente como *Cyanoplax* Pilsbry, 1892. Evidencias preeliminares indican que el taxón hermano de *Cyanoplax* está compuesto por *Nuttallina* spp. (Monofilético en si mismo) más *L. beanii* del Golfo de California, *L. liozonis* del Caribe, y *L. turtoni* de Sud África. Dendrochiton Berry, 1911, el cual Kaas y Van Belle han considerado ser un sub género de *Lepidochitona*, tiene por lo tanto que ser considerado como un taxón hermano de Mopalia Gray, 1847; lo cual tiene sentido porque los miembros de *Dendrochiton* y *Mopalia* se parecen uno al otro. *Tonicella* Carpenter, 1873, el cual Kaas y Van Belle han considerado que están en la misma subfamilia como *Lepidochitona*, también parecen tener mayor afinidad con otros miembros del clado del norte del Pacífico que incluye *Mopalia*, *Dendrochiton* y *Cryptochiton* Middendorff, 1847. Esta nueva conclusión para *Cyanoplax* spp. ha hecho posible estudiar la evolución de los rasgos reproductivos como la crianza y el hermafroditismo dentro del género.

A new method for genome size estimation in *Haliotis rufescens* (Archaeogastropoda: Haliotidae) using dapi-fluorescence fading

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Nuclear genome size is an important characteristic of a species which determines the capacity of that species to undergo evolutionary change. This type of analysis may be especially useful in biodiversity studies and determination of ploidy levels in genetically manipulated species. Several methods have been used to quantify genome size. DNA extraction has been reported as imprecise, because it is necessary to determine the number of nuclei from which the DNA is extracted. An alternative technique, using the quantification of fluorescence intensity in nuclei stained with DNA-specific fluorochromes. This technique has been widely applied in flow cytometry and with great success in determinating genome size. However, this method requires both for the sample to be in suspension and for a large number of nuclei to analyze. Recently, densitometric techniques using Feulgen reaction combined with image analysis has been demonstrated to be useful and a simple method for genome size estimation. The disadvantage of this technique is the Feulgen stain protocol. Basically, the Feulgen stain requires a strong hydrolysis with hydrochloric acid 1 N at 60°C or 5 N at 20-30°C, which will affect the efficacy of the stain. In this work, we present a new method for genome size estimation using DAPI-fading fluorescence (DFF) combined with image analysis processing. Fluorescence fading is a phenomenon which occurs when a fluorochrome is excited by a specific wavelength light and its fluorescence intensity decreases with time. The hypothesis considered in this work is that fluorescence fading is proportional to genome size. Red abalone spermatozoa were stained with DAPI. Digital images were taken every 1.6 sec. during 800 sec. and computer analyzed.

Fluorescence fading was plotted against time and the area under the curve was considered to be related with the cell DNA content. Tilapia (*Oreochromis mossambicus*) sperm and red blood cells were used for comparison of genome size. Our results show that the measurement of DFF in *Haliotis rufescens* spermatozoa is a mathematic function of the DDF value in *O. mossambicus* (C=0.81 pg). The genome size in *H. rufescens* was estimated in C=1.76 pg.

Un nuevo método para la estimación del tamaño genómico en *Haliotis rufescens* (Archaeogastropoda: Haliotidae) mediante desvanecimiento dapi-fluorescente

Una importante característica en las especies es el tamaño genómico nuclear, el cual determina la capacidad de la especie de experimentar cambios evolutivos. Este tipo de análisis puede ser especialmente útil en estudios de biodiversidad y determinación de niveles de ploidía en especies genéticamente manipuladas. Diversos métodos han sido utilizados para cuantificar el tamaño genómico. El método de extracción de ADN ha sido descrito como impreciso, debido a que es necesario determinar el número de núcleos de los cuales se extrajo el ADN. Una técnica alternativa, utiliza la cuantificación de la intensidad de fluorescencia en núcleos teñidos con fluorocromos específicos para ADN. Esta técnica ha sido ampliamente aplicada en procedimientos de citometría de flujo y con gran éxito en la determinación de tamaño genómico. Sin embargo, este método requiere que la muestra se encuentre en suspensión, además de gran número de núcleos por análisis. Recientemente, técnicas densitométricas utilizando la reacción de Feulgen combinada con análisis de imágenes han demostrado ser útiles y son un método sencillo para estimar tamaño genómico. La desventaja de este método involucra el protocolo para la tinción de Feulgen. Básicamente, la tinción de Feulgen requiere una fuerte hidrólisis con Ácido hidroclorhídrico 1 N a 60°C ó 5 N a 20°C, el cual puede afectar la eficiencia de la tinción. En este trabajo, presentamos un nuevo método para estimar el tamaño genómico usando desvanecimiento DAPI-fluorescente (DDF), combinado con procesamiento de análisis de imágenes. El desvanecimiento de la fluorescencia es un fenómeno que ocurre cuando un fluorocromo es excitado por una longitud de onda específica y su intensidad de fluorescencia disminuye con el tiempo. La hipótesis considerada en este trabajo, es que el desvanecimiento de la fluorescencia es proporcional al tamaño genómico. Espermatozoides de abulón rojo fueron teñidos con DAPI. Imágenes digitales fueron capturadas cada 1.6 s durante 800 s y analizadas por computadora. El desvanecimiento de la fluorescencia fue graficado a través del tiempo y el área bajo la curva fue considerada como relativo al contenido de ADN celular. Espermatozoides y glóbulos rojos de tilapia (*Oreochromis mossambicus*) fueron utilizados para comparar el tamaño genómico. Nuestros resultados muestran que las mediciones de DDF en espermatozoides de *Haliotis rufescens* son una función matemática del valor de DDF en *O. mossambicus* (C=0.81 pg). El tamaño genómico en *H. rufescens* fue estimado en C=1.76 pg.

Phylogeography and diversity of the eastern Pacific coast

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The global climate and geologic record document a transition to upwelling in the middle Miocene (@15-mya). Paleontologic and molecular clocks indicate that a significant component of the uniquely diverse temperate marine fauna of the coastal North Pacific radiated at this time. This diversity appears to have been sustained in the North Pacific through hiatuses in upwelling in the Pliocene and Pleistocene that eliminated diversity in other upwelling regions around the world. An additional historical factor is the presence of significant embayments along the California coast in the Miocene and Pliocene that supported warm water faunas. Upwelling and embayments are the likely sources of much of the faunal diversity now found in the Gulf of California.

Filogeografía y diversidad de la costa Pacífico del este

El clima global y el registro geológico documentan una transición hacia un afloramiento en el Mioceno medio (@15-mya). Los relojes paleontológicos y moleculares indican que un componente significativo, de la particularmente diversa fauna marina templada de la costa norte del Pacífico, irradió en este tiempo. Esta diversidad parece haber sido sostenida en el Pacífico Norte mediante interrupciones en afloramientos en el Plioceno y Pleistoceno que eliminaron la diversidad en otras regiones de afloramientos alrededor del mundo. Un factor histórico adicional es la presencia de bahías a lo largo de la costa de California en el Mioceno y Plioceno que favorecieron el desarrollo de fauna de aguas cálidas. Afloramientos y bahías parecen ser las fuentes de gran parte de la diversidad faunística que actualmente encontramos en el Golfo de California.

Morphometric analysis of *Chione cortezi* and *C. fluctifraga* (Bivalvia: Veneridae) of Gulf of California, Mexico

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The species *Chione cortezi* and *C. fluctifraga* have been assigned to the subgenus *Chionista* (Keen, 1958) based on their conchological characteristics. However, in some reports, the two species have been considered the same. *Chione cortezi* can grow to 88 mm, which makes it an important commercial species. In the 1980's, the geographic distribution of *C. cortezi* extended from Bahía Magdalena Baja California (Pacific coast of Mexico) to Guaymas Sonora (Gulf of

California). Nevertheless, in the last years, *C. cortezi* has been found only in the Alto Gulf of California, and it was considered endemic for this area. *Chione fluctifraga* (the ¨black clam¨) can grow to 51 mm. The objective of this work was to analyze the grade of morphological differentiation between *C. cortezi* and *C. fluctifraga* found in five localities of the Gulf of California. Twelve morphometric variables (characters of hinge, adductor muscle, escutcheon and lunule) were considered. The proportions of each one of the variables in relation to maximum valve length were analyzed according to the Discriminating Function Analysis (DFA) in order to determine which morphological features have the greatest important in differentiating between each locality and species. In addition, the Square Distance of Mahalanobis (D^2) was calculated to know the distributions of morphological distances between samples from each location of *C. cortezi* (¨A¨), *C. fluctifraga* (¨B¨), and unclassified specimens (species ¨C¨). The DFA demonstrated that the morphological variables analyzed were able to differentiate between localities of the same species, and even between species, with an 88% rate of correct classification. The distance between the two localities of *C. cortezi* was less (D^2= 5) than that between *C. fluctifraga—C. cortezi* (D^2=14 to 21). The distance between *C. fluctifraga*—species ¨C¨ was less (D^2= 8) than the range between *C. cortezi*—species ¨C¨ (D^2= 9 to 18). This analysis determined that species ¨C¨ possesses morphometric characteristics of *C. fluctifraga*, as many authors have classified it. Nevertheless, genetic population studies (allozyme electrophoresis) of these same groups determined that species ¨C¨ is genetically similar to *C. cortezi*. For those species in a similar situation, we suggest studies using our methodology, which integrates methods of morphometric analysis and population genetics.

Análisis morfométrico de *Chione cortezi* y *C. fluctifraga* (Bivalvia: Veneridae) del Golfo de California, México

Las especies *Chione cortezi* y *C. fluctifraga* fueron asignadas al Subgénero *Chionista* (Keen, 1958) debido a sus características conquiológicas. Sin embargo, existen reportes en los que se cita a una u otra especie de manera indistinta como si se tratara de una sola. *C. cortezi* es una especie que alcanza tallas de hasta 88 mm por lo que es capturada con fines comerciales. En la década de los 80, el área de distribución geográfica abarcaba desde Bahía Magdalena, en el Pacífico mexicano, hasta Guaymas (Sonora). Sin embargo, recientemente sólo se encontró en el Alto Golfo de California, por lo que fue considerada especie endémica de esta zona. *C. fluctifraga* es llamada comúnmente almeja negra y es consumida regionalmente como almeja coctelera, alcanzando tallas de hasta 51 mm. Debido a esta situación, en esta investigación se analizó el grado de diferenciación morfométrica entre *C. cortezi* y *C. fluctifraga* procedentes de cinco localidades del Golfo de California. Se consideraron 12 variables morfológicas que representan características de la bisagra, músculo abductor, estuche y lúnula. Las proporciones de cada una de las variables en relación a la longitud máxima de la valva se analizaron mediante el Análisis de Funciones Discriminantes (AFD) para determinar cuales características morfométricas tienen mayor importancia en la diferenciación de cada una de las localidades y especies. Además, se calcularon las Distancias Cuadradas de Mahalanobis (D^2) para conocer las distribuciones de las distancias morfométricas entre las muestras de las diferentes localidades: *C. cortezi* (especie A), *C. fluctifraga* (especie B) y entre organismos no clasificados de dos localidades (especie C). El AFD mostró que las variables morfométricas analizadas fueron útiles para diferenciar entre dos localidades de una misma especie e incluso entre especies con un porcentaje total de clasificación correcta de las muestras del 88%. La distancia entre dos

localidades de *C. cortezi* fue menor (D^2=5), que entre las especies *C. fluctifraga-C. cortezi* (D^2 =14 a 21). La distancia entre *C. fluctifraga*-especie C fue menor (D^2= 8) comparado al rango de *C. cortezi* -especie "C" (D^2= 9 a 18). Con este análisis se logró determinar que la especie "C" posee características morfométricas propias de *C. fluctifraga*, por lo que muchos autores la han clasificado de esta manera. Sin embargo, estudios de genética de poblaciones (electroforesis de alozimas) de estas mismas poblaciones revelaron que la especie catalogada como "C" es genéticamente similar a *C. cortezi.* Para aquellas especies que presentan esta misma situación, se sugiere aplicar un enfoque similar al del presente estudio, en el cual se integren los métodos de análisis de la morfometría y de la genética de poblaciones.

Genetic characterization of some populations of *Chione californiensis* and *C. subimbricata* (Bivalvia: Veneridae) in the Gulf of California and Pacific coast of Mexico

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Of the 25 species of *Chione* distributed in North Pacific waters, 15 species are found in the peninsula of Baja California. The species *C. californiensis* and *C. subimbricata* belong to the subgenus *Chione.* The commercial species *C. californiensis*, distributed from California, USA, to Peru is harvested commercially. However, *C. subimbricata,* found from the Gulf of California to Peru, is considered to have ecological importance. This is the first report about the determination of the population genetics of this species. The enzymes were extracted from homogenized tissues of the digestive gland and adductor muscle. Between 24 and 36 clams were obtained for experimentation. *Chione californiensis* was obtained from three different localities from the coasts of the Gulf of California (states of Baja California Sur and Sonora) and *C. subimbricata* was obtained from one locality of the Pacific coast of Mexico (state of Jalisco). The enzymes were analyzed by electrophoresis (PAGE) for 22 enzymatic systems. Between 18 and 21 loci were obtained from *C. californiensis* and 9 loci from *C. subimbricata.* For *C. californiensis,* 15 loci were not in Hardy-Weinberg (HW) equilibrium, 10 had heterozygote deficiency and 5 had heterozygote excess ($p \leq 0.001$). For *C. subimbricata,* 1 locus was not in HW equilibrium, and another has heterozygote deficiency ($p \leq 0.001$). The expected heterozygosity (He) varied from 0.456±0.032 to 0.466±0.025 for *C. californiensis.* The He for *C. subimbricata* was 0.457±0.050. The genetic identity of Nei was higher between the two subpopulations of Baja California Sur (I=0.936) than among them and the population of Sonora. The genetic identity between *C. californiensis* and *C. subimbricata* was the highest (I=0.897), when other species such as *C. cortezi*, *C. fluctifraga* and *C. gnidia* were included in the analysis. These results agree with the report of the inclusion of *C. subimbricata* in the subgenus *Chionopsis.* The inbreeding coefficient of *C. californiensis* (FIS=0.120) showed intrapopulation homogeneity. The fixation index (FST=0.046) showed a reduced population structure and the Global Inbreeding Coefficient (FIT=0.162) showed that there is no reproductive isolation among the organisms from the

different localities. Although few localities were studied in this work, we found a strong association between the patters of oceanic circulation and the F statistics, which indicated an effect over the population structure of *C. californiensis*. Further work is recommended by increasing the number of loci and the geographic populations of each species to understand the intra- and interspecific relationships as well as the effect of the oceanographic factors on the population structure.

Caracterización genética de algunas poblaciones de *Chione californiensis* y *C. subimbricata* (Bivalvia:Veneridae) en el Golfo de California y el Pacífico Mexicano

En la Península de Baja California, México se registran 25 especies de *Chione* de las cuales 15 se distribuyen en el Pacífico Americano. De acuerdo con Keen (1971) las especies *C. californiensis* y *C. subimbricata* pertenecen al Subgénero *Chione*. *C. californiensis* habita desde California, EE.UU. a lo largo del Golfo de California hasta Perú, es una especie explotada comercialmente a nivel regional. *C. subimbricata* tiene una distribución geográfica más restringida desde el Golfo de California hasta Perú y su importancia es fundamentalmente ecológica. El objetivo de la presente investigación fue determinar el grado de diferenciación genética, la estructura poblacional y la identidad genética Nei (I) por medio del análisis de alozimas. Este estudio es el primero en su tipo ya que no existen antecedentes de estudios publicados sobre genética de poblaciones de esta especie. Las enzimas se extrajeron de homogeneizados de glándula digestiva y músculo abductor de entre 24 y 36 almejas procedentes de tres localidades de las costas del Golfo de California, México (Sonora y Baja California Sur) de *C. californiensis* y de una localidad del Pacífico mexicano (Jalisco) de *C. subimbricata*. Se analizaron en electroforesis en geles de poliacrilamida para 22 sistemas enzimáticos de los cuales se obtuvieron entre 18 y 21 loci para *C. californiensis* y 9 loci para *C. subimbricata*. De los loci ensayados para *C. californiensis* 15 se desviaron del Equilibrio de Hardy-Weinberg (EHW), 10 tuvieron deficiencia de heterocigotos significativa y 5 exceso de heterocigotos significativa ($p \leq 0.001$). En *C. subimbricata* de los 9 loci obtenidos, uno se desvió del EHW y otro presentó deficiencia de heterocigotos significativa ($p \leq 0.001$). La heterocigosidad esperada (He) varió de 0.456 ± 0.032 a 0.466 ± 0.025 para *C. californiensis* y de 0.457 ± 0.050 para *C. subimbricata*. La similitud genética de Nei fue mayor entre las dos subpoblaciones de Baja California Sur (I=0.936) que entre éstas y la población de Sonora. Entre las dos especies *C. californiensis* y *C. subimbricata* la similitud genética (I=0.897) fue la más elevada cuando en el análisis se incluyen a otras especies como *C. cortezi*, *C. fluctifraga* ambas del Subgénero *Chionista* y *C. gnidia* del Subgénero *Chionopsis*. Estos resultados concuerdan con la inclusión de *C. subimbricata* dentro del subgénero *Chionopsis* como lo propuso Keen. El coeficiente de endogamia *C. californiensis* (FIS=0.120) demostró la existencia de homogeneidad intrapoblacional. El índice de fijación (FST=0.046) indicó una reducida estructuración poblacional y el Coeficiente de Endogamia Global (FIT=0.162) reveló que no existe aislamiento reproductivo de los organismos de las distintas localidades. A pesar del reducido número de localidades incluidas en el presente estudio, es evidente la asociación entre los patrones de circulación oceánica y los estadísticos F que indicaron un efecto sobre la estructura poblacional de *C. californiensis*. Se recomienda ampliar los estudios sobre la caracterización genética de las especies de este género, incrementando el número de loci y de poblaciones geográficas de cada especie con el fin de dilucidar más claramente las relaciones dentro y entre las especies así como el efecto de los factores oceanográficos sobre la estructura poblacional.

DNA sequence test of the lined chiton (*Tonicella*) species complex

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West Coast chitons commonly known as lined chitons have long been identified as *Tonicella lineata* (Wood, 1815) but, in 1999, R. N. Clark proposed that these were actually a species complex comprised of four distinct species, two of which Clark described as new. However, the criteria Clark used to make these distinctions were primarily related to the shell coloration patterns, which had been previously interpreted as mere intraspecific variations. In his favor, the color and line-pattern variants appeared to have different, albeit somewhat overlapping, geographical and bathymetric distributions. DNA sequence comparisons were thus employed to test the validity of Clark's hypothesized species distinctions. Of the four *Tonicella* species considered by Clark, our study emphasized the two that most commonly live in intertidal habitats: *T. lineata* (ranging from Alaska to central California) and *T. lokii* (ranging from northern to central California). According to Clark, these putative species differ most obviously in the pattern of lines on the head shell plate, with either a "gothic arch" (*T. lineata)* or a zigzag (*T. lokii*) pattern of arching lines. Portions of the mitochondrial genes, *cox* I and 16S ribosomal DNA, were compared in this study in order to analyze genetic variation among sampled individuals. Our results strongly support Clark's distinctions between *T. lineata* and *T. lokii*, as well as the monophyly of each. For example, *T. lineata* from central California (where it is rare) grouped unambiguously with *T. lineata* from Washington and Alaska, not with central California *T. lokii*. An unanticipated result was our preliminary discovery of phylogeographic separation among populations of *T. lokii* from Monterey and San Luis Obispo counties in central California, whereas *T. lineata* showed no such structure throughout its much greater range (Alaska to California). In comparison to the included outgroups, we also supported the monophyly of a group comprised of *T. lineata*, *T. lokii*, and the other of Clark's new species, *T. venusta*, however it will likely require further sampling of *T. venusta* to resolve relationships among these three species. Likewise, we expect to extend these sequence comparisons to additional populations, other *Tonicella* spp., and additional outgroups in order to better resolve relationships within this genus.

Prueba de secuenciación de ADN para el complejo de especies de Quiton Rayado *Tonicella*)

Los quitones de la Costa Oeste comúnmente conocidos como quitones rayados han sido ampliamente identificados como *Tonicella lineata* (Wood, 1815) pero, en 1999, R. N. Clark propuso que éstos forman un grupo de cuatro especies distintas, dos de las cuales Clark ha descrito como nuevas. Sin embargo, el criterio que utilizó Clark para hacer esas distinciones primeramente está relacionado con los patrones de coloración de la concha, los cuales previamente han sido interpretados como resultado de variaciones intraespecíficas. A favor de las deducciones de Clark, las variaciones en el color y los patrones lineales parecen estar relacionados con una distribución geográfica y batimétrica diferente, aún cuando hay ciertas sobreposiciones. Para probar la validez de las observaciones de Clark se emplearon comparaciones de secuenciación de ADN. De las cuatro especies de *Tonicella* consideradas por

Clark, nuestro estudio destacó a dos de ellas que habitan en el intermareal: *T. lineata* (que se distribuye desde Alaska hasta California central) y *T. lokii* (que habita del norte al centro de California). De acuerdo con Clark, estas especies putativas difieren marcadamente en su patrón de líneas sobre la concha, *T. lineatta* presenta una especie de “arco gótico” mientras que *T. lokii* presenta un patrón en zigzag de líneas arqueadas. Se compararon los fragmentos de los genes mitocondriales, cox I y el 16S ribosomal ADN, fueron comparados en este estudio para analizar la variación genética entre los individuos muestreados. Los resultados apoyan fuertemente las diferenciaciones de Clark entre *T. lineata* y *T. lokii*, así como la monofilia de cada uno. Por ejemplo, *T. lineata* de California central (donde es raro) se agrupó inequívocamente con *T. lineata* de Washington y Alaska, y no con *T. lokii* de California central. Un resultado anticipado fue nuestro descubrimiento preeliminar de la separación filogenética de *T. lokii* de los condados de Monterey y San Luis Obispo en California central, mientras que *T. lineata* no mostró tal estructura en todo su amplio rango de distribución geográfica (Alaska a California). En comparación a los grupos externos, apoyamos la monofilia del grupo comprendido por *T. lineata*, *T. lokii*, y la otra nueva especie de Clark, *T. venusta*; sin embargo, se requieren de muestreos adicionales de *T. venusta* para resolver las relaciones entre estas tres especies. Igualmente, esperamos extender estas comparaciones de las secuencias en poblaciones adicionales, otras *Tonicella* spp., y otros grupos adicionales para dilucidar las relaciones dentro de este género

IV. AQUACULTURE SESSION
SESIÓN ACUACULTURA

Organized by/ Organizado por
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The rainbow lip pearl oyster *Pteria sterna* cultured in Bahía de La Paz: Tradition and modernity

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Pearl oyster culture in Bahía de La Paz (BLP) was very famous at the end of the XIX century because of the technical advances employed at that time. The main products were mother of shell (used for buttons) and natural pearls. Nevertheless, oyster culture ended with social conflicts and the Mexican revolution of 1910. Many efforts were invested in the second half of the past century to bring back the activity but the results of different research groups were not rewarded until 1980, when natural beds had recovered and the feasibility of pearl culture was realized. The commercial culture of pearl oysters in BLP restarted in 1999, using the natural spat fall of the rainbow lip pearl oyster *(Pteria sterna)*. The growth and survival results allowed, after 18 months of culture, the seeding of the animals to obtain two products: the “mabé” (half pearls)

and free pearls. The first product is the basis for the actual development of pearl oyster aquaculture in the bay. The second is of greater imporance because it advances implantation techniques and the skills needed for large-scale production techniques. The animals with the implants are cultured for at least two years to permit enough deposit of nacre over the artificial nucleus. The culture technique is still the original and it is particular to the Gulf of California. The technique consists on four stages: collection of juveniles, intermediate culture, grafting or nucleation, and culture. The most sensitive stage is the intermediate culture (60% survival). Nucleation activities show different results, 90% survival for "mabé" pearls and 31-35% of retention rate for free pearls (60% survival). The last stage of culture is a stable period with survival from 80 to 90%. The average time for the production takes 3 years for the "mabé" pearls and 4 years for the free pearls. The "mabé" are cut directly from the shells and prepared for their use in jewelry. The rest of the shells are used to manufacture mother of pearl buttons (for clothing). The powder from the shell is used to prepare lotions for therapeutic and cosmetic uses. The free pearls are classified and used directly for jewelry.

Cultivo de concha nácar *Pteria sterna* en la Bahía de la Paz: Tradición y modernidad

El cultivo de la concha nácar *Pteria sterna* en la Bahía de La Paz fue muy reconocido a finales del siglo XIX debido, entre otros aspectos, a los avances tecnológicos empleados en esa época. Los productos principales eran la concha madre (para fabricación de botones) y la perla natural. Sin embargo, conflictos sociales y la revolución Mexicana de 1910 terminaron con esta actividad. Durante la segunda mitad del siglo XX, diferentes grupos de investigación realizaron valiosos esfuerzos para iniciar nuevamente el cultivo de ostras perleras. Estos esfuerzos fueron recompensados en 1980, cuando se recuperaron los bancos naturales y se evaluó la factibilidad técnica y económica del cultivo. El cultivo comercial en la Bahía de La Paz, se reinició en 1999, a partir de la captación de semilla del medio natural. El desarrollo y la supervivencia obtenidos permitieron la obtención de dos productos: el "mabé" (media perla) y la perla completa. El primer producto es la base del cultivo actual de ostras perleras en la Bahía. El segundo va cobrando mayor importancia, conforme se avanza en el dominio de la técnica de implantación y la capacitación del personal para llegar a niveles de producción a gran escala. Los animales con los implantes se cultivan por al menos dos años para permitir suficiente depósito de nácar sobre los núcleos artificiales. La tecnología de cultivo se divide en cuatro fases: recolecta de semilla, cultivo intermedio, implantación de núcleos y cultivo. La fase más delicada es la segunda, donde se obtiene una supervivencia del 60%. En la implantación de núcleos se obtienen diferentes resultados, 90% de supervivencia de ostras con perlas mabé y 60% para ostras con perlas completas y un porcentaje de retención del 31 a 35%. La última fase de cultivo es la más estable, con valores de supervivencia del 80 al 90%. El tiempo promedio para producción de mabés es de 3 años y de 4 años para perlas completas. Las mabés se cortan directamente de las conchas y se preparan para su uso en joyería. El resto de las conchas es usado para la fabricación de botones. La concha molida en polvo se utiliza para fabricación de lociones terapéuticas y cosméticas. Las perlas completas se clasifican y usan directamente para joyería.

Evaluation of growth rate of *Lyropecten* (*Nodipecten*) *subnodosus* cultured in three different temperatures and fed with three bi-algal diets

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The culture of bivalves on a commercial scale has been developed for few species due to the lack of biological and ecological information on other bivalves with aquacultural potential. The commercial value of and aquacultural interest in the lion claw clam, *Lyropecten* (*Nodipecten*) *subnodosus,* has increased in the last years. However, there are some problems associated with its culture such as larval production and high seed mortality. The objective of this work was to evaluate the effect of temperature and type of diet on the growth of seeds of *L.* (*N.*) *subnodosus*. The culture of seeds was performed in a closed system for 10 weeks. Three temperatures (23, 26 and 29 °C) and three bi-algal diets (M1: *Pavlova lutheri-Chaetoceros calcitrans*; M2: *Pavlova lutheri-Isochrysis* sp. and M3: *Isochrysis* sp.- *Chaetoceros calcitrans*) were evaluated. Shell length and height were recorded weekly and organic dry weight was recorded every 2 weeks. The results of this work showed the effect of the diet on the growth of the organisms. The highest growth rate was found in organisms fed with the diet M3 independent of temperature. The shell length increase of the organisms was between 272 and 273% and the shell height increase was between 278 and 280%. The highest organic dry weight was found in organisms cultured at 26°C independent of the diet. Weight increase was between 2447 and 2955%. A mortality rate of over 50% was found after the second week of experimentation in organisms cultured at 29°C. Thus, survival of organisms cultured at this temperature was recorded up to the beginning of the third week.

Evaluación del crecimiento de *Lyropecten* (*Nodipecten*) *subnodosus* cultivada en tres diferentes temperaturas y alimentada con tres dietas bialgales

El cultivo de moluscos bivalvos a nivel comercial se ha dirigido solamente a un número pequeño de especies pertenecientes a este grupo, debido principalmente a la escasa información acerca de la biología y ecología de otras especies de bivalvos. La almeja mano de león *Lyropecten* (*Nodipecten*) *subnodosus* es un bivalvo que en los últimos años ha incrementado su valor comercial y el interés de productores acuícolas para su cultivo, teniendo los principales problemas en la obtención de larva y la alta mortalidad en la etapa de semilla. El objetivo del presente trabajo fue el de evaluar el efecto de la temperatura y la dieta en el crecimiento de *L.* (*N.*) *subnodosus* en etapa de semilla. Los cultivos de semillas se realizaron en un sistema cerrado durante 10 semanas, se evaluaron tres temperaturas (23, 26 y 29 °C) y tres dietas bialgales (M1: *Pavlova lutheri-Chaetoceros calcitrans*; M2: *Pavlova lutheri-Isochrysis* sp. y M3: *Isochrysis* sp.- *Chaetoceros calcitrans*), semanalmente se obtuvieron la longitud y ancho de la concha, y

quincenalmente el peso seco orgánico de los organismos. Los resultados obtenidos mostraron un efecto de la dieta en la longitud y ancho de las semillas, registrándose los valores mayores en los organismos alimentados con la dieta M3 independientemente de la temperatura, alcanzando un incremento entre el 272 y 273 % en longitud y de 278 a 280 % en el ancho de la concha. Con relación al peso seco orgánico, se obtuvieron los mayores resultados en los organismos cultivados a 26 ºC independientemente de la dieta, con incrementos entre el 2447 a 2955 % de su peso. Mortalidades de más del 50 % de los organismos se registraron después de la segunda semana en los cultivos mantenidos a 29 ºC, por lo cual los resultados a esta temperatura se reportaron hasta el inicio de la tercera semana.

Daily growth of early stages of sympatric mussels as criteria to differentiate colonization strategy

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Substrate colonization by mussels may occur when larvae are competent to settle (250-470 mμ) and reach optimal conditions for growth, or by post larvae when they are drifting in water column (500- 4000 μm) after settlement on a suboptimal substrate. Differentiation of the two strategies for colonization has ecological and practical significance, either for the same species or among different mussel species. To determine if a substrate is colonized by competent larvae or post larvae, it is necessary to know the maximum size of competent larvae after a determinate period of growth on the substrate. Larger mussels than expected after this period of time correspond to post larvae colonizing stages. In order to know the growth rate of early stages of coexisting *Mytilus galloprovincialis* and *Mytilus californianus* and take these values as reference to estimate the maximum growth on a substrate after a determinate period of time, early stages of both species were cultured in 1 L vessels at 18°C ± 1 and salinity of 35 ppt. Mussels were feed with 10ml of *Isochrysis galbana* (16 millions ml^{-1}) during a period of 20 days. Daily growth of *M. californianus* was 18.20 ± 0.80 μm and daily growth of *M. galloprovincialis* was 33.70 ± 0.80 μm. Analysis of these different growth rates of both species showed that *M. galloprovincialis* have a slower growth than *M. californianus*, allowing their competitive exclusion from new substrates. This information also allows us to place collectors to obtain competent larvae or post-larvae for culture.

Crecimiento diario de estadios tempranos de mejillones coexistentes para diferenciar su estrategia de colonización

La colonización del substrato por parte de *Mytilus* spp. ocurre cuando la larva es competente (250-470 m_μ) y alcanza condiciones óptimas para establecerse y desarrollarse. También puede ocurrir por post-larvas que se encuentran a la deriva en la columna de agua (500- 4000 _μm) después de haberse fijado en un substrato subóptimo. La diferenciación de ambas estrategias para

la colonización del substrato, tiene importancia ecológica y práctica inter e intraespecíficamente. Para determinar si un substrato en particular es colonizado por larvas competentes o post-larvas, es necesario conocer la talla máxima que podría alcanzar una larva competente sobre un sustrato después de un período de tiempo determinado. Los mejillones que alcancen una talla mayor a la esperada, se habrán asentado sobre el mismo como post-larvas. Para determinar el desarrollo diario de estadios tempranos de *Mytilus galloprovincialis* y *Mytilus californianus* que habitan como especies simpátricas en la costa del Pacífico de Baja California y así, tener las estimaciones de crecimiento necesarias para diferenciar la estrategia de asentamiento sobre un sustrato determinado, se colocaron estadios tempranos de ambas especies en recipientes de 1 L a 18°C ± 1 y salinidad de 35 ppm. Los mejillones se alimentaron con 10ml de *Isochrysis galbana* (16 millones ml^{-1}) por un período de 20 días. El crecimiento diario de *M. californianus* fue de 18.20 ± 0.80 _μm mientras que el desarrollo diario de *M. galloprovincialis* fue de 33.70 ± 0.80 _μm. El análisis de estas tasas de desarrollo para ambas especies nos dio los valores de referencia para diferenciar el asentamiento inter- e intraespecífico de larvas competentes y post-larvas sobre un sustrato determinado. Por otro lado, se observó que *Mytilus galloprovincialis* muestra un crecimiento mas lento, lo que puede contribuir a su desplazamiento por parte de *Mytilus californianus* durante la colonización de nuevos sustratos. Las diferentes tasas de desarrollo también nos permiten utilizar sustratos para captar tanto larvas competentes, como post-larvas para ser usadas en cultivo.

Settlement of mytilids and its importance to mussel culture in Baja California, México

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Knowing the settlement season for mussels in a particular locality is important to determine when to place seed collectors for culture. Seed collection from nature is the most practical and economic method for mussel culture. This method is empirically used in Bahía de Todos Santos, Baja California; however, there is a lack of scientific information to support criteria to validate or improve this practice. Thus, the goal of this study was to use artificial collectors to determine the season and abundance of mytilid settlement in the culture area of the Bahía de Todos Santos and in a natural exposed mussel bed in Ejido Eréndira. Collectors were nylon ropes (CN), polypropylene ropes (CP), cotton and polypropylene ropes (CAP) and synthetic commercial fiber (FS). Collectors were sampled monthly during 2 years, from December 1994 to November 1996. In the culture area collectors were placed at 2 and 5 meters depth. In Ejido Eréndira they were placed in the middle intertidal zone. Collectors were transported individually to the lab, where mussels were detached, sized and counted. The season of settlement in Bahía de Todos Santos was autumn and winter in both years. However, abundance was different between years and collector type (10,164 in 1995 and 232,270 mussels in 1996). In Ejido Eréndira the settlement season was winter and summer. Abundance was similar in 1995 and 1996, 44,141 and 53,166 mussels, respectively. The best collector determined by the density of spat was FS for both years and both localities. Differences in settlement season between localities could be related to the

species. *Mytilus californianus* is dominant in natural exposed mussel beds such as Ejido Eréndira, and *Mytilus galloprovincialis* is dominant in protected localities such as Bahía de Todos Santos. These results suggest that artificial seed collectors could be placed during late autumn and early winter in Bahía de Todos Santos. In Ejido Eréndira collectors could be placed from late autumn and early winter, and during summer.

Fijación de mitílidos y su importancia para el cultivo de mejillón en Baja California, México

El conocer la época de fijación de una especie de mejillón en una localidad es importante para establecer cuándo y en qué zonas colocar los colectores de semillas para cultivo. La obtención de semilla del medio natural es el método más práctico y económico para abastecer al cultivo. Este método se usa empíricamente en la Bahía de Todos Santos en Baja California; sin embargo, se carece de información científica que sustente o mejore la obtención de semilla en colectores artificiales en la zona. Por tal motivo, el objetivo del presente estudio fue determinar la estación y abundancia de la fijación de mejillones en la zona de cultivo de la Bahía de Todos Santos y en un banco natural de mejillón del Ejido Eréndira usando diferentes colectores artificiales. Se utilizaron como colectores artificiales cuerdas de nailon (CN), de polipropileno (CP), algodón con polipropileno (CAP) y trozos de fibra sintética comercial (FS), los cuales fueron reemplazados cada mes durante un período de dos años, de diciembre de 1994 a noviembre de 1996. Los colectores se colocaron en el área de cultivo a 2 y 5 m de profundidad y en el Ejido Eréndira en la zona media del intermareal. Los colectores se transportaron individualmente en bolsas de polietileno al laboratorio, donde todos los mitílidos fijados fueron separados, medidos y contados. La fijación de mitílidos en la Bahía de Todos Santos ocurrió a finales de otoño y principios de invierno en los dos años estudiados; sin embargo, su abundancia fue diferente, en 1995 con 10 164 y 232 270 mejillones en 1996. También se observaron diferencias en la abundancia de la fijación por tipo de colector. En el Ejido Eréndira la fijación ocurrió en invierno y verano en los dos años estudiados. La abundancia de la fijación fue similar, en 1995 con 44 141 y en 1996 con 53 166 mejillones. El colector que mostró mayor captación de semilla de mejillón fue FS en ambos años de muestreo y en ambas localidades. Las diferencias en la temporalidad de la fijación entre localidades puede estar relacionada con la especie de mitílido: *Mytilus californianus* es dominante en las zonas naturales expuestas, como el caso del Ejido Eréndira, mientras que *Mytilus galloprovincialis* es dominante en las bahías protegidas como en Bahía de Todos Santos. De acuerdo a los resultados obtenidos se recomienda colocar los colectores a finales del otoño en la Bahía de Todos Santos y a principios de la primavera, mientras que en el Ejido Eréndira es recomendable colocarlos a finales del otoño y durante el verano.

Genetic advancements on cultured abalone in Baja Caliornia

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Abalones, *Haliotis* spp., are an economic resource in Baja California. The fishery started at the beginning of the 20th century, but research on abalone genetics only started seven years ago. In this paper we present the genetic work done on cultured abalone in comparison with wild populations. Allożyme analysis has shown an adjustment to Hardy-Weinberg equilibrium in several abalone batches and there is an apparent relationship between heterozygosity and shell length. Furthermore, we will present a RAPD analysis of a recirculation-cultured abalone, along with karyotypic analysis and genome size of the abalone.

Avances en la genética del abulón cultivado en Baja California

Los abulones, *Haliotis*, spp. tienen una gran importancia económica en Baja California, su pesquería comenzó al inicio del siglo 20, pero los estudios genéticos apenas iniciaron hace siete años. En este trabajo presentamos los estudios realizados en el abulón cultivado en comparación con las poblaciones silvestres. Se ha encontrado, por medio del análisis alozímico, que existe un ajuste al modelo del Hardy-Weinberg en varios lotes y que existe una aparente correlación entre el crecimiento de organismos y el grado de heterocigosidad. Asimismo se presentará el análisis genético obtenido con RAPD en un sistema de recirculación, el cariotipo y el tamaño genómico del abulón cultivado.

Growth and gametogenic cycle of the palmate oyster, *Saccostrea palmula* (Bivalvia: Ostreidae), in El Conchalito Estuary

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Introduction

The palmate oyster *Saccostrea palmula* (Carpenter, 1857) is an important commercial and subsistence resource in many estuaries along the Pacific coast from San Ignacio Lagoon, México, and the Gulf of California, to Ecuador and the Galapagos islands, including Isla del Coco, Costa Rica (Skoglund, 2001). In Mexico, *S. palmula* occuring in mangrove swamps are

attached to roots of *Rhizophora mangle* and *Laguncularia racemosa*. This species also attaches to rocks, especially on reefs exposed to surf, in depths to 7 m.

The genus *Saccostrea* is considered as a synonym of *Crassostrea* by Lawrence (1995).

There have been several reports published on the reproductive cycle of this species, and it is recognized as a good candidate for culture because of its high fecundity and good growth rate, reaching commercial size (50- mm shell length in natural conditions) in one year.

The present study was done to evaluate and standardize data and to describe the growth and the reproductive cycle of the *S. palmula* in the coastal waters of Bahía de La Paz. CICIMAR-IPN has been working with the park management plan´s regulations of local fisheries and new activities.

Materials and Methods

Study area

The lagoon of El Conchalito is a small mangrove forest (area 20 hectares) inside of the Ensenada de La Paz. It is on the Gulf of California coast of Baja California Sur in the southern part of Bahía de La Paz, between 24°07'-24°08' N and 110°20'-110°21' W. This narrow lagoon is separated from the sea by a straight sand bar about 0.5 km long. Tides in the lagoon are semidiurnal, with a maximum tidal range of 2.36 m, with strong tidal currents (31 $cm.s^{-1}$). The lagoon environment is hypersaline (36-42‰).

Sampling, Measurements and Statistical Analysis

The reproductive cycle was studied over a 17-month period. To determine the gametogenic cycle and growth, 30 oysters were collected monthly, measured for shell length and whole weight, and a gonadal sample was taken for histological analysis. Using standard histological techniques for analysis, each section of gonadal slide was sexed, and assigned to a development stage. A staging criteria of 1 to 5 was employed for undifferentiated (1), developing (2), ripe (3), spawning (4), and spent (5). For the a regression analysis was performed with the weight and the size. We tested sex ratios against a 1:1 ratio with Chi-square statistics.

Results and Discussion

Growth

The oysters grow attached to prop roots of *Rhizophora mangle* 25 to 40 cm above sea level, in the low intertidal zone. Within this habitat, *S. palmula* had an average density of 1.5 live ind/m^2, with maximum of 3 ind/m^2.

In Magdalena Bay, García-Pámanes (1978) found densities between 0.5 to 947 live ind/m^2. Oysters grew from a mean size of 26.2 mm in October 1998 to 37.5 mm by October 1999-a rate of 0.9 mm per month (Fig. 1).

Gametogenic cycle

Of 287 oysters sectioned for histological examination, males dominated the population (43.9%) with only 13.2% females and 42.8% indeterminates. Gametogenic development was synchronous between males and females. Indeterminate oysters occurred in most months of the year. Gametogenesis, spawning and spent oysters occurred in the summer months (Fig. 2). In males, spawning and spent stages ranged from 37.6% of the oysters in September to 67% in October, with females in these stages ranged from 17% in August to 72% in October. The study population was dominated by large adults (20-45 mm shell length). The sex ratio of males and females were 3:1, and there was no evidence of hermaphroditism. The reproductive cycle

described here is similar to other palmate oyster populations occurring in northern México (Cuevas y Martínez, 1978).

Conclusions

This species appeared to be slow-growing, averaging about 0.9 mm/month in length and of 0.16 g/month in wet weight. Population density is low. The estimated growth parameter K had a low value of 0.3 and 88.2 mm, with 4 years age. Indeterminate oysters occurried in most months, and reproductively active (with gametogenesis, and spawning and spent) oysters occurring at El Conchalito in summer months.

Acknowledgements

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Fig. 1. Mean monthly shell length, +/- s.d. and isometric growth for *S. palmula*

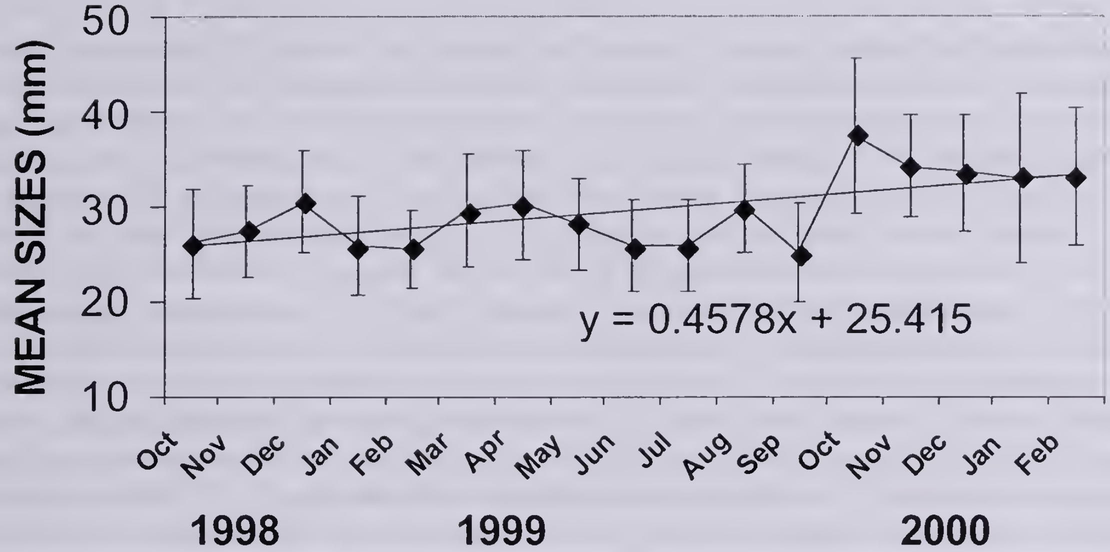
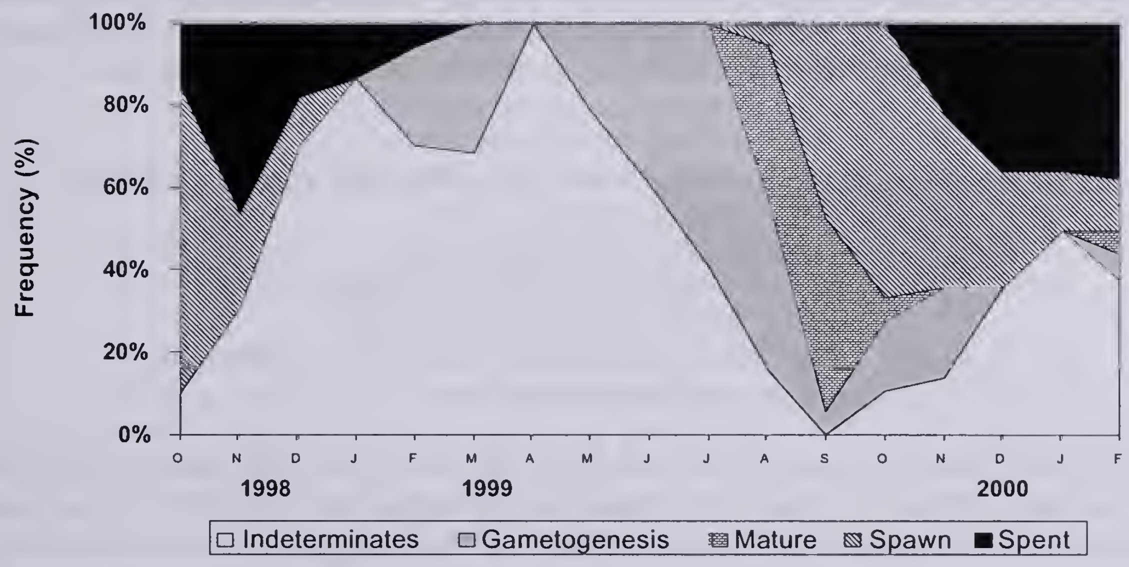


Fig. 2. Monthly percent frequencies of the reproductive phases for male and female palmate oysters in El Conchalito



Desarrollo y ciclo gametogénico del ostión palmeado, *Saccostrea palmula* (Bivalvia: Ostreidae), en el Estero El Conchalito

El ostión palmeado *Saccostrea palmula* (Carpenter, 1857) es un recurso comercial y de subsistencia de gran importancia para las poblaciones de pequeños poblados que habitan a lo largo de la costa del Pacífico, desde la Laguna San Ignacio y el Golfo de California en México hasta Ecuador y las islas Galápagos. El ostión se fija a las raíces de los mangles y/o rocas, especialmente sobre arrecifes expuestos al oleaje y hasta profundidades de 7 m. Se han publicado varios registros sobre el ciclo reproductivo de esta especie y se le reconoce como un buen candidato para cultivo debido a su gran fecundidad y tasa de crecimiento. En condiciones naturales alcanza la talla comercial en un año, que es de unos 50 mm. El presente trabajo describe el desarrollo y ciclo reproductivo de *S. palmula* en las aguas costeras de la Bahía de la Paz. El ciclo reproductivo fue estudiado por un período de 17 meses. Para determinar el desarrollo y el ciclo gametogénico de los ostiones, se recolectaron mensualmente 30 ejemplares. Se midió la longitud de la concha y se tomaron muestras de la gónada para análisis histológico. Los resultados mostraron que los ostiones se desarrollaron de una talla media de 26.2 mm en octubre de 1998 a 37.5 mm en octubre de 1999 (0.9 mm por mes). De 287 ostiones examinados, 43.9% fueron machos, 42.8% se encontraron en estado indiferenciado y 13.2% fueron hembras. El desarrollo gametogénico entre hembras y machos fue sincrónico. Se encontraron ejemplares en estadio indiferenciado durante todo el año. En los meses de verano se observó la gametogénesis, desoves y estadios de reposo. El porcentaje de machos en estadio de desove y de reposo varió de 37.6% de ejemplares en septiembre, a 67% en octubre. En las hembras, estos estadios variaron de 17% en agosto a 72% en octubre. En la población estudiada, hubo un predominio de adultos grandes (20-45 mm longitud de la concha). La proporción de sexos entre machos y hembras fue de 3:1 y no se encontraron hermafroditas. El ciclo reproductivo descrito en este estudio, es similar al registrado en ostiones de otras localidades del Norte de México.

Aquaculture of abalone *Haliotis* spp. in Isla de Cedros, Baja California, Mexico

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Abalone aquaculture in Isla de Cedros started with purpose of recovering the natural abalone population, which had been exposed to an indiscriminate exploitation in the 1960's. In that time, the production, fertilization and release of fertilized ova to the sea was named "seed tide," a technique developed by Biol. Martín Ortíz Quintanilla. In the 1980's abalones were transported to other areas with better conditions for growth, such as food availability, currents and protection. Moreover, the fishery in certain areas was closed to allow the recovery of abalone there. These areas remained closed for about 3 years, and then were opened to the fishery. In the early 1990´s a small laboratory was built to produce abalone larvae and seed in order to restore the natural population and to respond to the authority's request for this pupose. During that time,

an experimental abalone culture using 200 liter barrels in the sea was attempted. Results were favorable, allowing a promising technology for abalone aquaculture. In 2003 a project to develop this technology to commercial production is in evaluation.

Acuicultura del abulón *Haliotis* spp. en Isla de Cedros, Baja California, México

La acuicultura del abulón en Isla de Cedros, se inicia con la finalidad de restablecer los bancos abuloneros sometidos a una intensa pesca en la década de los sesentas. A la producción, fertilización y liberación de huevos fertilizados en esa época se le denominó "mareas de cría", técnica atribuida al Biol Martín Ortíz Quintanilla. En la década de los ochentas se realizaron trasplantes de organismos de una zona a otra con la finalidad de colocarlos en mejores condiciones de alimentación, refugio y corrientes marinas. También se efectuó el cierre de bancos abuloneros a la captura comercial para restablecerlos. Estos bancos se abrieron nuevamente a la captura comercial, después de más de 3 años. A principio de los noventa se construyó un pequeño laboratorio de producción de larvas y semillas de abulón con la finalidad de repoblar los bancos y dar cumplimento a las condiciones de la concesión de captura que prevén el repoblamiento de los bancos abuloneros, mediante la siembra de larva competente y semilla producida en estas instalaciones. También se realizó un experimento de engorda de semilla de abulón producida en laboratorio en barriles de 200 litros con buenos resultados. Estos resultados han dado las bases para el desarrollo del maricultivo del abulón en la zona. En 2003 se presentó un proyecto para ampliar el laboratorio con el fin de iniciar el cultivo comercial de abulón que se encuentra actualmente en evaluación.

Preliminary studies on the cryopreservation of red abalone (*Haliotis rufescens*) larvae

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The culture of abalone in Baja California, México, is a growing industry that requires supporting technologies. Cryopreservation of gametes or larvae offers several benefits. For example, sperm and larvae can be easily transported among hatcheries, selective breeding can be improved, stocks can be maintained and a resource of genes can be kept for advanced studies. The objectives of this work were to: 1) determine the acute toxic effect of three cryoprotectants and 2) assess the optimum freezing and thawing rates for trochophore larvae of red abalone. To determine the acute toxic effect, larvae were incubated in dimethylsulfoxide (DMSO), propilenglycol or glycerol, in three different concentrations (1%, 3% or 5%) for 5 or 10 min. Significant differences were found among the larvae maintained in the different cryoprotectants ($P = 0.0002$). No significant differences were found for larvae incubated in the concentrations of 3% and 5% ($P=0.4630$). Dimethylsulphoxide showed to be the less toxic in all the concentrations

and incubation times. The highest survival was found for larvae incubated in 3% DMSO at 10 min. Two experiments were performed to assess the optimum freezing and thawing rate. In the first experiment, larvae were incubated in 3% DMSO and 3% propilenglycol for 10 min. One thousand larvae per milliliter were placed in 0.5-mL straws, 5-mL macrotubes or 1.5-mL cryovials. After incubation, the samples were placed on a plastic screen in a Styrofoam box containing liquid nitrogen and were frozen at 1.5°C/min. from a temperature of 15°C to –35°C. The samples were held for 5 min and then plunged in liquid nitrogen. In the second experiment, the larvae were incubated in 5% DMSO or 5% propilenglycol for 10 min. One thousand larvae per milliliter were placed in 0.5-mL straws. After incubation, samples were frozen as experiment 1 to a freezing rate of 2.5°C/min. Two thawing temperatures were used: 45°C for 7 s, for 0.5-mL straws and 70°C for 5-mL macrotubes and 1.5-mL cryovials until ice crystals were not visible. No larvae survival was found after samples were thawed in either of the treatments. These results are the first attempt to freeze red abalone larvae in Mexico. Although we found the best cryoprotectant, we need more studies to determine the optimal freezing and thawing rates. However, these experiments are the beginning of new research on the cryopreservation of larvae of aquatic species of commercial and biological importance from Mexico.

Estudios preeliminares sobre la criopreservación de larvas de abulón rojo (*Haliotis rufescens*)

El cultivo de abulón en Baja California, México es una industria en desarrollo que requiere de apoyo tecnológico. La criopreservación de gametos o larvas ofrece varios beneficios. Por ejemplo, el esperma y las larvas pueden transportarse fácilmente entre laboratorios, se puede mejorar la reproducción selectiva, se pueden mantener reproductores y se puede mantener una fuente de genes para estudios avanzados. Los objetivos de este trabajo fueron: 1) determinar el efecto tóxico agudo de 3 crioprotectantes y 2) valorar las tasas de congelación y descongelación para larvas trocóforas de abulón rojo. Para determinar el efecto tóxico agudo, las larvas se incubaron en dimetilsulfóxido (DMSO), propilenglicol o glicerol, a 3 concentraciones (1%, 3% y 5%) por 5 o 10 min. Se encontraron diferencias significativas entre las larvas mantenidas en diferentes crioprotectantes ($P = 0.0002$). No se encontraron diferencias significativas entre las larvas incubadas a 3% y 5% ($P=0.4630$). El DMSO fue menos tóxico a las concentraciones y tiempos de incubación estudiados. La mejor supervivencia se encontró en las larvas incubadas a 3% DMSO por 10 min. Para determinar las tasas de congelación y descongelación se llevaron a cabo dos experimentos. En el primer experimento las larvas se incubaron a 3% DMSO y 3% propilenglicol por 10 min. Mil larvas por mililitro se colocaron en pajillas de 0.5-mL, 5-mL macrotubos o 1.5-mL crioviales. Después de la incubación, las muestras se colocaron en una malla en una caja de estireno con nitrógeno líquido y se congelaron a 1.5°C/min. de una temperatura de 15°C a –35°C. Las muestras se mantuvieron por 5 min. y se sumergieron en nitrógeno líquido. En el segundo experimento, las larvas se incubaron en 5% DMSO ó 5% propilenglicol por 10 min. Como en el caso anterior, se colocaron 1000 larvas por mL en pajillas de 0.5-mL. Después de la incubación las larvas se congelaron tal como se describió para el experimento 1, a una tasa de congelación de 2.5°C/min. Se usaron dos temperaturas de descongelación: 45°C for 7 s, para las pajillas de 0.5-mL y 70°C para macrotubos de 5-mL y crioviales de 1.5-mL hasta que no se observaron cristales de hielo. En ninguno de los tratamientos hubo supervivencia de larvas después de que las muestras se descongelaron. Aún cuando encontramos el mejor crioprotectante, necesitamos más estudios para determinar las tasas

de congelación y descongelación adecuadas. Estos experimentos constituyen el comienzo de la investigación sobre criopreservación de larvas de especies acuáticas de importancia biológica y comercial en México.

Culture of juvenile red abalones, *Haliotis rufescens*, in a recirculating water system

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In Mexico, Baja California is the only state where abalone is cultured commercially. The most common culture system is a flow through system. Although some attempts to culture abalone using recirculation systems have been recently performed, no reports had been produced. The objective of this work was to evaluate the growth rate and survival of red abalone cultured in recirculation and flow through systems. The recirculation system consisted of a 250-liter fiberglass tank, biofiltration was provided by a 1 ft^3 bubble washed bead filter. The flow through system consisted of a 250-liter tank with a daily water exchange rate of 800%. Constant aeration was provided throughout the experiment. Dissolved oxygen, temperature, pH and salinity were monitored daily. Total ammonia nitrogen (TAN), nitrate-nitrogen, nitrite-nitrogen and alkalinity were monitored three times weekly. Shell length was measured every two weeks for 18 weeks. All experiments were performed in triplicate. No significant differences in the temperature, dissolved oxygen, salinity, TAN, nitrate-nitrogen and nitrite-nitrogen and salinity were found. Alkalinity and pH were significantly different due to the addition of sodium bicarbonate. Abalone growth rates were 26.9±15.96 µm/day in the recirculation system and 23.28±18.69 µm/day in flow through system. Survival of juveniles was 78.7% for organisms in the recirculation system and 71.8% for organisms in the flow though system. Significant differences in final abalone size were found between systems ($p<0.01$). Therefore, recirculating systems are a feasible alternative for the culture of juvenile red abalone.

Cultivo de juveniles de abulón rojo, *Haliotis rufescens*, en un sistema de recirculación

En México, Baja California es el único estado donde se cultiva el abulón bajo un sistema de cultivo abierto. A pesar de que se han hecho intentos para cultivar abulón en sistemas de recirculación en la zona, no existen publicaciones sobre los resultados obtenidos. El objetivo de este trabajo fue evaluar la tasa de desarrollo y supervivencia de abulón rojo cultivado en un sistema de recirculación y en un sistema abierto. El sistema de recirculación estuvo compuesto por un estanque de fibra de vidrio de 250-l, la biofiltración se realizó por un filtro de cama de burbuja de 1 ft^3. El flujo a través del sistema fue de una tasa de recambio de 800%. Durante todo el estudio se mantuvo aireación constante. Diariamente se registraron los valores de oxígeno disuelto, temperatura, pH y salinidad. El amonio total (TAN), nitrato-nitrógeno, nitrito-nitrógeno

y alcalinidad se registraron dos veces por semana durante 18 semanas. Los experimentos se realizaron por triplicado. No hubo diferencias significativas en temperatura, oxígeno disuelto, salinidad, TAN, nitrato-nitrógeno y nitrito nitrógeno. La alcalinidad y el pH fueron diferentes debido a la adición de bicarbonato de sodio. La tasa de desarrollo del abulón fue de 26.9 ± 15.96 µm/dia en el sistema de recirculación y de 23.28 ± 18.69 µm/dia en el sistema abierto. La supervivencia de los juveniles fue de 78.7% en el sistema de recirculación y de 71.8% en los organismos mantenidos en sistema abierto. Las diferencias en crecimiento de los abulones en ambos sistemas fue significativa ($p<0.01$). Los sistemas de recirculación para cultivo de abulón representan una alternativa factible.

V. GENERAL SESSION
SESIÓN GENERAL

Organized by/ Organizado por
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Macrobenthonic molluscan thanatocoenoses in the Colorado River Delta area as a reflection of ecological changes

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The aim of this study was to evaluate the thanatocoenosis composition of shallow molluscan shelly fauna in the tidal flats of the Colorado delta. Ten transects and 112 stations were sampled in 1999 and 2000 (winter-summer) in five localities: 1) Campo Don Abel (north of San Felipe), in winter and summer; 2) Isla Vega, in winter; 3) Isla Sacatosa, in winter and summer; 4) Estero Chayo (Isla Montague), in winter; and 5) front of La Reserva de la Biosfera del Río Colorado (north of Golfo de Santa Clara, Sonora), in winter. The localities 1 and 2 were named south zone, and localities 3 to 5 north zone. The fauna identified for all localities is composed of 122 species. Bivalves were the most abundant with densities from few to thousands of individuals per m^2. The fauna was more abundant in the upper mesolitoral, and the taxonomic composition and abundance differs between the north and south zones. In general, the most abundant species were the bivalves *Mulinia coloradoensis* and *Tellina meropsis*. In the living fauna, *M. coloradoensis* is extremely scarce, which suggests that thanatocoenoses are paleoecological windows to understand ecological changes of the Colorado River delta attributed to the river's water deflection.

Tanatocenosis de moluscos macrobentónicos en el área del Delta del Río Colorado como un reflejo de cambios ecológicos

El objetivo de este estudio fue evaluar la composición de la tanatocenosis de la fauna de moluscos de aguas someras en las planicies mareales del delta del Río Colorado. Se realizaron 10 transectos y se establecieron 112 estaciones que se muestrearon en 1999 y 2000 (invierno-verano) en cinco localidades: 1) Campo Don Abel (norte de San Felipe), en invierno y verano; 2) Isla Vega, en invierno; 3) Isla Sacatosa, en invierno y verano; 4) Estero Chayo (Isla Montague), en invierno; y 5) Reserva de la Biosfera del Río Colorado (norte del Golfo de Santa Clara, Sonora), en invierno. Las localidades 1 y 2 se denominaron zona sur, y las localidades 3 a 5 zona norte. La fauna identificada para todas las localidades está compuesta por 122 especies. Los bivalvos fueron los más abundantes con densidades de algunos cientos de individuos por m^2. La fauna fue más abundante en la zona alta del mesolitoral, y la composición taxonómica y abundancia es diferente entre la zona norte y sur. En general, las especies más abundantes fueron los bivalvos *Mulinia coloradoensis* y *Tellina meropsis*. En la fauna viviente, *M. coloradoensis* es extremadamente escasa, lo cual sugiere que la tanatocenosis puede considerarse como ventana paleoecológica para entender los cambios ecológicos del delta del Río Colorado atribuidos a la deflexión del agua del río.

What happened to the bearded horse mussel at Bahia de los Angeles? (some after thoughts and possible microorganism identification)

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While a guest of the Maricopa Community College Field Station at Bahía de los Ángeles, and snorkeling along the rocky tidal area, the author noticed a die off of the bearded horse mussel (*Modiolus capax*) in its early stages. This was reported in The Festivus, 1990, and at WSM Asilomar, 1992. While employed at UCSD Medical Center, the author had an opportunity to make thin sections of tissues of *Modiolus capax* stained with Hematoxylin and Eosin, and with a special stain of PAS for carbohydrates. My search for a microbiologist to identify the causative organism of the die off was unsuccessful. The identification of the microorganism would confirm the reason for the die-off. A few mussels and interstitial bivalves were dying each day. The population of the mussel was devastated and the beaches deep in shells. Three well and three sick bivalves were secured for microscopic studies at the time. Some years ago these wet specimens were all transferred to Dr. Terrence M. Gosliner at the California Academy of Sciences, along with all my wet specimens of opisthobranchs. Chances are that the rocky habitat at Bahía de los Ángeles might have another marine life die off. Knowing the name of the microorganism would help close this chapter for now. The samples will be sent to a pathology laboratory of aquatic organisms to identify the microorganism causing such mortalities.

¿Qué ocurrió al mejillón caballo barbado en Bahía de los Ángeles? (algunas reflexiones posteriores y posible identificación de microorganismos)

Mientras fui invitado de la estación de campo del Maricopa Community College en Bahía de Los Ángeles, buceaba a lo largo de la zona rocosa intermareal y observé gran número de ejemplares muertos del mejillón caballo barbado *Modiolus capax*. Estas mortalidades ocurrían diariamente y afectaban a otros moluscos de la zona. La población de mejillón fue devastada y las playas se llenaron de conchas vacías. Recolecté tres mejillones de apariencia saludable y tres aparentemente enfermos y los conservé. Estas observaciones las reporté en Festivus en 1990 y en la reunión de la WSM en Asilomar. Cuando trabajé en el UCSD Medical Center tuve la oportunidad de realizar algunos cortes histológicos de *M. capax* los cuales teñí con hematoxilina-eosina, así mismo utilicé la tinción PAS para carbohidratos. Busqué a un microbiólogo para identificar al presunto organismo causal de aquellas mortalidades visto en los tejidos del molusco pero no obtuve ningún resultado. Hace algunos años, envié mis especímenes junto con algunos opistobranquios al Dr. Terrence M. Gosliner de la Academia de California, quien me dio nuevas pistas sobre la posible identidad del microorganismo encontrado en los tejidos del mejillón. Es probable que en Bahía de Los Ángeles ocurran otras mortalidades de fauna marina que pudiesen relacionarse con ese microorganismo. Por lo anterior es importante conocer su identidad y determinar si está relacionado o no con dichas mortalidades. Hace unas semanas envié mis laminillas histológicas al Laboratorio de Biología y Patología de Organismos Marinos del CICESE para obtener mayor información al respecto.

Notes on the knowledge of the freshwater mollusks of México

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Advances in the ongoing project named "Catalogue of the non-marine mollusks of Mexico" are presented with emphasis on the freshwater pulmonates. The catalogue is based mainly in records gathered from the literature and observations from a collection owned by the author, which contains specimens from different regions of the country. The families recognized are: Lymnaeidae, Physidae, Planorbidae and Ancylidae. Three lymnaeid genera are recorded: *Fossaria*, *Pseudosuccinea* and *Stagnicola.* For the Physidae, Taylor's new monograph recognizes seven genera for Mexico: *Austrinauta*, *Amecanauta*, *Mexicanauta*, *Mayabina*, *Haitia*, *Chiapaphysa* and *Ultraphysella* and has reduced several previously recognized species into only 15. For the Planorbidae, six genera are recorded: *Gyraulus*, *Drepanotrema*, *Biomphalaria*, *Helisoma*, *Planorbella* and *Planorbula* and for the Ancylidae, three genera: *Ferrissia*, *Gundlachia* and *Hebetancylus*. Many species of freshwater mollusks are distributed widely over the country but, in contrast, some species of Physidae and Planorbidae have narrow distribution patterns. These may be due to inadequate collecting. Thus, this study invites further surveys to confirm their endemism. For example, *Planorbula* has only been collected in the north (state of Tamaulipas) and south of the Gulf of Mexico (state of Quintana Roo). More studies are needed in these states to investigate its presence or absence over the extensive area in between. This may provide an explanation for its apparently discontinuous distribution. In addition, it seems that the

integrity of the native freshwater mollusk of Mexico is being threatened by the now invasive species *Corbicula fluminea* and *Melanoides tuberculata.* These species have been recorded in numerous freshwater bodies across the entire country. Personal observations revealed that in some cases, native species are now restricted to certain parts of invaded areas, particularly when many *Melanoides tuberculata* dominate the habitat.

Notas sobre el conocimiento de los moluscos de agua dulce de México

Se presentan avances del proyecto denominado “Catálogo de los moluscos no marinos de México” con énfasis en los pulmonados de agua dulce. El catálogo se basa en registros obtenidos de la literatura y de observaciones de la colección propiedad del autor. Esta contiene especímenes de diferentes regiones del país. Las familias reconocidas son: Lymnaeidae, Physidae, Planorbidae y Ancylidae. Se registran tres géneros de lymnaeidos: *Fossaria*, *Pseudosuccinea* y *Stagnicola.* Para Physidae, la nueva monografía de Taylor reconoce 7 géneros para México: *Austrinauta*, *Amecanauta*, *Mexicanauta*, *Mayabina*, *Haitia*, *Chiapaphysa* y *Ultraphysella* y ha reducido a sólo 15 las especies previamente reconocidas. Para Planorbidae, se han registrado 6 géneros: *Gyraulus*, *Drepanotrema*, *Biomphalaria*, *Helisoma*, *Planorbella* y *Planorbula* y para Ancylidae, 3 géneros: *Ferrissia*, *Gundlachia* y *Hebetancylus.* Muchas especies de moluscos de agua dulce se distribuyen ampliamente a lo largo del País pero, en contraste, algunas especies de Physidae y Planorbidae tienen estrechos patrones de distribución. Esto puede deberse a recolectas inadecuadas. Así, este estudio invita a realizar investigaciones para confirmar este endemismo. Por ejemplo, *Planorbula* se ha recolectado solamente en el norte (estado de Tamaulipas) y al sur del Golfo de México (estado de Quintana Roo). Se necesitan más estudios en esos estados para investigar sobre su presencia o ausencia sobre áreas extensas y en zonas intermedias. Esto podría proveer de una explicación a esta aparente distribución discontinua. Además, parece que la integridad de moluscos nativos de agua dulce de México está siendo amenazada ahora por especies invasoras como *Corbicula fluminea* y *Melanoides tuberculata.* Estas especies se han registrado en numerosos cuerpos de agua dulce a lo largo de todo el País. Observaciones personales revelan que en algunos casos, las especies nativas están ahora restringidas a ciertas partes de zonas invadidas, particularmente cuando muchas *Melanoides tuberculata* dominan el hábitat.

Paleontology and geochronology of Pleistocene marine terrace faunas, Punta Banda, northwestern Baja California

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Twelve well-preserved, and additional less well-preserved, Pleistocene marine terraces are present on peninsular Punta Banda, a structural block bounded by two major faults, the Agua Blanca on the north and the Maximinos on the south. Fossil marine invertebrate faunas, however, are known only from the first, third, and fifth terraces. Based on amino acid racemization studies on bivalve mollusks, and uranium-series disequilibrium analyses of hydrocorals (*Stylaster californicus*) and solitary corals (*Balanophyllia elegans*), the lowest, "Lighthouse Terrace," dates to about 80,000 years BP, correlative with marine oxygen isotope ($\delta^{18}O$) substage 5a. The third, "Sea Cave Terrace," dates to about 120,000 years BP, correlative with isotope substage 5e. The fifth terrace, based on altitudinal spacing of the lower terraces, is assigned an age of about 330,000 years BP, correlative with the sea-level highstand of isotope stage 9. Fossil marine invertebrate faunas, mainly mollusks, on the first, substage 5a, terrace contain several cool-water, extralimital northern species, whereas faunas from the third, substage 5e, terrace contain several warm-water, extralimital southern species on the protected northern side of the peninsula, but lack *any* extralimital species, southern or northern, on the southern side. Upwelling on the southern side of the peninsula may reduce surface water temperatures by as much as 8 °C compared to those on the protected northern side. Due to variable uplift rates and neotectonic activity, marine terrace faunas from the lowest emergent terrace at Alisitos-La Fonda, to the north, and from the second emergent terrace at Maximinos, to the south, correlate with those of the third, substage 5e terrace on Punta Banda.

Paleontología y geocronología de la fauna de terrazas marinas del Pleistoceno en Punta Banda, noroeste de Baja California

En Punta Banda, una placa estructural limitada por dos grandes fallas, la de Agua Blanca al norte y la de Maximinos al sur, se encuentran doce terrazas marinas del Pleistoceno bien preservadas y una pocas terrazas adicionales no bien preservadas. Sin embargo, la fauna fósil de invertebrados marinos se conoce únicamente en la primera, tercera y quinta terraza. Basándonos en estudios de racemización de aminoácidos en moluscos bivalvos y en análisis discontínuos en

series de mediciones de uranio de hidrocorales (*Stylaster californicus*) y corales solitarios (*Balanophyllia elegans*), la terraza más baja "Lighthouse Terrace," data de 80,000 años BP, correlativo con el isótopo de oxígeno marino ($\delta^{18}O$) subetapa 5a. La tercera terraza "Sea Cave Terrace," data de 120,000 años BP, correlativo con el isótopo subetapa 5e. La quinta terraza, de acuerdo con el espaciado altitudinal de las terrazas más bajas, se le asigna una edad cercana a los 330,000 años, correlacionado con el nivel del mar del isótopo de la etapa 9. Los fósiles de la fauna de invertebrados marinos, principalmente moluscos, de la primera terraza subetapa 5a, contienen especies norteñas de aguas frías, mientras que la fauna de la tercera terraza subetapa 5e, contiene especies sureñas de aguas cálidas sobre el lado norteño protegido de la península, pero carece de especies al norte y sur del lado sureño. Las surgencias sobre el lado sur de la peninsula pueden reducir la temperatura del agua superficial por más de 8°C en comparación con el lado norte. Debido a las tasas variables de levantamiento y a la actividad neotectónica, la fauna de las terrazas marinas más bajas emergen en Alisitos-La Fonda, al norte y la segunda terraza emerge en Maximinos, al sur, que está correlacionada con la tercera terraza, subetapa 5e de Punta Banda.

Lipid composition and fatty acid profile related to spawning cycle of the queen conch *Strombus gigas* (Linnaeus) from the National Park of Arrecife de Alacranes, Yucatán

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Tourism and high human consumption have contributed to the over-exploitation of natural populations of snails in the genus *Strombus*. These populations have fallen dramatically in Caribbean and Mexican waters since 1982. Due to overfishing and the increasing danger of extinction for these snails, the Mexican Government closed the *Strombus* fishery in 1987. Although fishing regulations is one method for population recovery, mariculture is an alternative to be evaluted. To be able to culture any of these species, it is necessary to know the relationship of the types and classes of lipids with the reproductive cycle of each species. This work determines the lipid composition and fatty acid profile during the reproductive cycle of the queen conch *Strombus gigas* (Linnaeus). The experiment was carried out for two years (2002-2003) in the protected area of Arrecife de Alacranes. Extraction and separation of lipids was that used by Privett *et al.*, and fatty acids were determined by gas mass chromatography. Different organs were sampled before, during and after spawning. Total lipid composition was determined during all three stages of the spawning cycle. The determination and quantification of the fatty acid profile measured the abundance of saturated, monosaturated and polyunsaturated fatty acids in relation with the numbers of eggs produced during spawning months. It was observed that the number of eggs decreased the saturated fatty acids and increased the unsaturated. It was determined that phospholipids represented the highest percentage of quantified lipids; this held true for all body organs studied. Before and during ovulation there is a greater quantity of saturated fatty acids, and less during ovulation. The monosaturated and polyunsaturated fatty acid levels are just the opposite during the beginning and final stages of spawning. These important data contribute an actual and definite way for CONAPESCA to legislate a closed season, based on scientific results. Likewise, this agency can give incentives for the fishery

sector to develop the mariculture of this species, corresponding to the exact timing of the spawning cycle, hence supporting the closed season. This project was carried out with teams of thesis, resident and Social Service students.

Determinación de la composición de lípidos y obtención del perfil de ácidos grasos con relación al ciclo de desove en el caracol marino *Strombus gigas* (Linnaeus) en el Parque Nacional de Arrecife de Alacranes, Yucatán

El desarrollo del turismo y la alta demanda han contribuido a la sobreexplotación de poblaciones naturales de las especies de caracoles del Género *Strombus*, cuyas poblaciones han disminuido drásticamente en el Caribe y en México desde 1982. Debido a la sobrepesca y ante el peligro creciente de la extinción del caracol, el Gobierno Mexicano prohibió la pesca del caracol en 1987. A pesar de que la regulación pesquera es uno de los medios para recuperar las poblaciones explotadas, la maricultura es una alternativa que debe evaluarse. Para lograr el cultivo de alguna de estas especies, es necesario conocer los tipos y clases de lípidos y la relación que tienen con el ciclo reproductivo de la especie. Por lo anterior, el propósito de este trabajo fue determinar la composición de lípidos y obtener el perfil de los ácidos grasos presentes en el caracol marino adulto *Strombus gigas* (Linnaeus) relacionado con su ciclo de desove. La metodología que se utilizó para la extracción y separación en clases de lípidos fue la de Privett *et al.* y para determinar el perfil de los ácidos grasos se usó la cromatografía de gases acoplado a un detector de masas. Los resultados comprenden muestras obtenidas durante 2002 y 2003. Se consideró tomar muestras desde el inicio y hasta el final del período de desove. Se determinó la composición de lípidos totales en tres etapas del ciclo del desove por órganos. Se determinó y cuantificó el perfil de ácidos grasos en cuanto a la abundancia de ácidos grasos saturados, monosaturados y poliinsaturados y se relacionó con el número de puestas en los meses de desove observándose que al aumentar el número de puestas disminuyen los ácidos grasos saturados y aumentan los insaturados. Se determinó y cuantificó la composición de los lípidos presentes y se obtuvo el mayor porcentaje para los fosfolípidos. Se compararon las clases de lípidos por órganos observando que el mayor porcentaje fue también para los fosfolípidos no importando el órgano analizado. Se llegó a la conclusión que antes y después del desove hay una mayor cantidad de ácidos grasos saturados y durante el desove disminuyen y sucede lo contrario con los monosaturados y poliinsaturados que durante el desove aumenta y al final disminuyen. Esta información obtenida es valiosa pues contribuye de una manera aplicada y definitiva a las autoridades de la CONAPESCA para la implantación del período de veda apoyado con estos resultados científicos, mismos que darán incentivo al sector pesquero para el desarrollo de la maricultura de estas especies en relación con el periodo exacto del ciclo de desove que apoya al periodo de veda. Para la realización de este proyecto se formaron recursos humanos con tesistas y alumnos de residencia y servicio social.

Molluscan taphonomy and paleoecology at Mesa San Carlos, Baja California, México

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The Paleocene molluscan fauna at Mesa San Carlos, Baja California, is diverse and characterized by an excepcional preservation state, which made it possible to evaluate thaphonomic processes involved during and before final burial and to diminish paleoecological bias. From 56 species identified only two were very abundant: *Volutocorbis crassitesta* (26.5%) and *Amauropsis martinezensis* (16.8%). Less abundant but common were: *Polinices pynionensis*, *Turritella peninsularis qualyei*, *Cucullaea mathewsonii* and *Turritella reversa*. Most species were rare and account for less than 2%. Taphonomic features such as fragmentation, abrasion and bioerosion were evaluated by ternary thaphograms. Results suggest that the shells remained a short time on the surface. A fast burial is also indicated by sedimentological characteristics which correspond to storm deposits or tempestites. From the later, the fossil assemblage could be classified as parautochthonous because it is composed of environmentally compatible organisms, disarticulated, transported, and concentrated within or very close to the original habitat. The dominance of *V. crassitesta* and *Amauropsis martinezensis*, species restricted to cold waters today, and the fact that 52 species of 28 overlap on distribution, suggest a warm climate, very similar to the adjacent ocean today, This indicates that there has not been considerable latitudinal displacement since the Paleocene, as has also been supported by micropaleontological evidence.

Tafonomía y paleoecología de Moluscos en la Mesa, San Carlos, Baja California, México

La fauna de moluscos del Paleoceno en la Mesa San Carlos, Baja California, es diversa y se caracteriza por un excepcional estado de conservación, el cual hace posible evaluar el proceso tafonómico ocurrido durante y después del enterramiento final y también hace posible disminuir el sesgo paleoecológico. De las 56 especies identificadas sólo 2 fueron muy abundantes: *Volutocorbis crassitesta* (26.5%) y *Amauropsis martinezensis* (16.8%). Menos abundantes pero communes fueron: *Polinices pynionensis*, *Turritella peninsularis qualyei*, *Cucullaea mathewsonii* y *Turritella reversa*. La mayoría de las otras especies fueron raras y representaron menos del 2%. Los caracteres tafonómicos más distintivos de las conchas como la fragmentación, abrasión y bioerosión se evaluaron por tafogramas ternarios, sugiriendo que permanecieron un corto tiempo sobre la superficie y que el enterramiento fue rápido, tal como lo indicaron las características de la sedimentación, las cuales se corresponden con depósitos de tormentas o tempestades. A partir de esta información, el agrupamiento fósil podría ser clasificado como para autóctono porque está compuesto de organismos ambientalmente compatibles, desarticulados, transportados y concentrados dentro o muy cerca de su hábitat original. La dominancia de *V. crassitesta* y *Amauropsis martinezensis*, restringidas a aguas frías actualmente y el hecho de que 28 especies de 52 se sobreponen en distribución, sugiere un clima cálido, muy similar al del océano adyacente hoy en día. Esto indica que no ha ocurrido un

desplazamiento latitudinal considerable desde el Pleistoceno, tal y como ha sido concluido por la evidencia micropaleontológica.

Genetic structure of the red octopus *Octopus maya* in the coasts of Yucatán

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The genetic population structure of the red octopus *Octopus maya* from the Peninsula of Yucatan, Mexico was determined by expression of isoenzymes previously analyzed by polyacrilamide gel electrophoresis. Samples of mantle of 25 organisms from 3 different localities were used to characterize the genotypic expression from 24 loci in 30 enzymatic systems. The program Tools for Population Genetic Analyses (TFPGA) version 1.3 was used to process data of genetic frequency of allozymes. We determine the parameters: descriptive statistics, F statistics, Genetic distances, Hardy-Weinberg equilibrium, UPGMA and number of migrants as indicator of gene flow. The heterozygosity range was 0.1010 for ME2 and 0.4978 for EST1. The average heterozygosity was 0.0925. The average heterozygosity for Fis (0.2253) and for Fst (0.174) indicated a heterozygote deficiency. However, this heterozygosity is between the ranges reported for species of marine invertebrates. The number of migrants calculated from the equation of Slatkin was 2.4 per generation, which indicated certain grade of variability among the populations and is consistent with the low values found for Nei's genetic distance, mainly, the lump that suggest the separation of the population of Rio Lagartos from the other populations (0.0066). We concluded that the population of *Octopus maya* has a certain grade of interpopulation genetic variability, which did not show the fragility of the subsistence of these populations.

Estructura genética del pulpo *Octopus maya* en las costas de Yucatán

Se determinó la estructura genética poblacional del pulpo rojo *Octopus maya* en la Península de Yucatán, México, mediante la expresión de isoenzimas en geles de poliacrilamida. Se utilizaron muestras del manto de 25 organismos, capturados en tres sitios de la Península de Yucatán, para caracterizar la expresión genotípica revelada por la expresión de 24 loci en treinta sistemas enzimáticos. Se utilizó el programa Tools for Population Genetic Analyses versión 1.3 (TFPGA) para procesar los datos de frecuencias génicas de aloenzimas de las poblaciones en estudio. Los parámetros determinados fueron: estadística descriptiva, estadística F, distancias genéticas, equilibrio de Hardy-Weinberg, UPGMA y el número de migrantes como indicador del flujo de genes. Los valores de heterocigosis, en un rango de 0.1010 para la ME 2 y de 0.4978 para la EST 1, con un valor de heterocigosis promedio de 0.0925, los de Fis un valor promedio de 0.2253 y los de Fst de 0.174 indican una deficiencia de heterocigotos pero que se encuentran dentro de los rangos registrados para especies de invertebrados marinos. El número de migrantes derivado de la ecuación de Slatkin resultó de 2.4 por generación, lo que en forma global indica un cierto grado de variabilidad entre las poblaciones y es consistente con los bajos valores de

distancia genética de Nei encontrados, particularmente el nodo que sugiere la separación de la población de Río Lagartos de las otras poblaciones estudiadas, con un valor obtenido de 0.0066. Por los resultados de este estudio, se concluye que las poblaciones de *Octopus maya* presentan un cierto grado de variabilidad genética interpoblacional que no refleja fragilidad en la subsistencia de estas poblaciones.

On the diet of two octopod species found at California cold seep ecosystems

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The octopod species *Octopus californicus* (Berry, 1911) and *Enteroctopus dofleini* (Wulker, 1910) have recently been found in cold seep ecosystems off the California coast. This research addresses the possibility that these octopod species feed on cold seep bivalves. *Octopus californicus* has been collected by trawl in cold seeps at 500 meters in the Santa Barbara Channel. The author examined trawl samples collected in 1997 and 1998 for evidence of octopus predation on cold seep bivalves. Specimens of the bivalve species *Lucinoma aquizonatum* (Stearns, 1890) and *Vesicomya elongata* (Dall, 1916) were examined for the presence of octopus beak holes. There were no specimens found with evidence of predation by *O. californicus*. *Enteroctopus dofleini* has recently been seen at cold seeps in Monterey Bay and off the Eel River in northern California. Specimens of the cold seep bivalve *Vesicomya pacifica* (Dall, 1891) collected at the Eel River cold seeps were examined for the presence of octopus beak holes. There were no specimens found with evidence of predation by *E. dofleini*. The diet of *O. californicus* is not well understood. In captivity, *O. californicus* responds positively to crabs, shrimp and small fish. However, *O. californicus* shows no interest in clams, mussels and snails. The diet of *E. dofleini* has been well researched. The diet is very diverse and includes a variety of invertebrates and fish. Invertebrates in the diet of *E. dofleini* include bivalves, gastropods, brachiopods and echinoderms. The varied diet of *E. dofleini* implies that this octopus species will feed on a wide variety of obligatory and nonobligatory invertebrates and fish species at cold seeps.

Dieta de dos especies de pulpo encontradas en ecosistemas de surgencia de agua fría en California

Los pulpos *Octopus californicus* (Berry, 1911) y *Enteroctopus dofleini* (Wulker, 1910) se han encontrado recientemente en ecosistemas de surgencias de aguas frías fuera de la Costa de California. Este resumen, señala la posibilidad de que esas especies de pulpos se alimenten de bivalvos de las zonas de surgencia de agua fría. *Octopus californicus* ha sido recolectado con dragas a 500 metros en el canal de Santa Bárbara. El autor examinó las muestras de la draga recolectadas en 1997 y 1998 buscando evidencias de la depredación de bivalvos de esas zonas por parte de los pulpos mencionados. Se examinaron las conchas de los bivalvos *Lucinoma aquizonatum* (Stearns, 1890) y *Vesicomya elongata* (Dall, 1916) buscando perforaciones que indicaran la acción depredadora de los pulpos. No se encontraron especímenes con tales evidencias de depredación por parte de *O. californicus*. *Enteroctopus dofleini* se ha visto

recientemente en los ecosistemas de surgencia de agua fría en la Bahía de Monterey y hacia fuera de Eel River al norte de California. Se revisaron especímenes del bivalvo de zonas de surgencia de agua fría, *Vesicomya pacifica* (Dall, 1891) recolectados en Eel River, en búsqueda de evidencias de depredación. Tampoco se encontraron especímenes con huellas de depredación por *E. dofleini*. No se ha conocido con precisión la dieta de *O. californicus*. En cautiverio, *O. californicus* se alimenta de cangrejos, camarones y pequeños pescados. Sin embargo, *O. californicus* no muestra interés cuando se le ofrecen como alimento almejas, mejillones y caracoles. La dieta de *E. dofleini* ha sido bien investigada. Esta es diversa e incluye una variedad de invertebrados y peces. Entre los invertebrados tenemos bivalvos, gasterópodos, braquiópodos y equinodermos. La diversa dieta de *E. dofleini* implica que esta especie de pulpo se podría alimentar con un amplia variedad de invertebrados y especies de peces de zonas de surgencia de agua fría.

Abyssal mollusk notes

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Abyssal Station M Megafauna Mollusks

The PULSE program under the direction of Dr. Ken Smith of the Marine Biology Research Division of the Scripps Institution of Oceanography has been involved with the long term monitoring of an abyssal ecosystem in the northeast Pacific off the coast of California since 1989. Abyssal Station M is located off the coast of Santa Barbara County 200 miles west of Point Conception (34°N 123° W). Otter trawl samples have been collected at depths of approximately 4100 meters. The following is a list of the mollusks collected at Station M: Bivalves: *Bathyarca corpulenta, Bathyneara disa, Ciclopecten neoceanus, Cuspidaria glacialis, Cyclopecten squamiformis, Ennucula cardara, Kelliela galathae, Ledella ultima, Lima* sp., *Limopsis tenella, Malletia truncata, Nucula profundum, Propeamussium meridionale, Setigloma japonica, Solemya* sp., *Tindaria compressa, Xylophaga* sp. Gastropods: *Neverita lamonae, Streiraxis aulaca, Tenebrincola cukri.* Scaphopods: *Fissidentalium actiniophorum, Rhabdus rectius.* Opistobranchs: *Scaphander* sp. Cephalopods: *Opisthoteuthis* sp.

A Variation of the Hydrothermal Vent Bivalve *Bathymodiolus thermophilus* Kenk and Wilson, 1985 (Bivalvia: Mytilidae)

In December of 1999, Dr. Horst Felbeck of the Marine Biology Research Division of the Scripps Institution of Oceanography collected an unusual specimen of *Bathymodiolus* while on an Alvin dive at the 9 North hydrothermal vents on the East Pacific Rise. The specimen was collected at 9°49.45750'N 104° 16.56115'W at a depth of 2549 meters. The specimen is 11.4 cm in length and was deposited in the Scripps Institution of Oceanography Benthic Invertebrate Collection. The specimen was collected in an area inhabited by *Bathymodiolus thermophilus* and is the same general shape as *B. thermophilus.* The differences are the specimen collected is more elongated in shape, not being as inflated as *B. thermophilus,* and the periostracum is black. The periostracum for *B. thermophilus* is normally yellow to brown in color. Only one specimen of the unusual *Bathymodiolus* was found at the hydrothermal vents where it was collected. There is no

reason to believe the *Bathymodiolus* specimen is nothing more than an individual variation of *B. thermophilus*.

The Solitary Abyssal Record for the Gastropod *Bathybembix bairdii* (Dall, 1889) (Gastropoda: Trochidae)

The gastropod *Bathybembix bairdii* (Dall, 1889) is an eastern Pacific species occurring at a depth of 300-1500 meters from the Bering Sea, Alaska to Punta San José, Baja California. The only abyssal record of the species is a trawl sample from the Panama Basin (5° 9.8'N 81° 41.2'W) at a depth of 3900-4000 meters. The sample was collected by the research team of Dr. Ken Smith of the Marine Biology Research Division of the Scripps Institution of Oceanography on October 8, 1981. A total of nine specimens were collected and are in the Scripps Institution of Oceanography Benthic Invertebrate Collection and the Malacology Collection of the Los Angeles County Museum. This is a new depth record and a new southern range extension for the species.

Herpes-like virus associated with eroded gills of the Japanese oyster *Crassostrea gigas* adults in Mexico

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Since 1997, high mortality episodes among cultured oysters have occurred in Bahía Falsa, Baja California, México. In the late 60's, studies on the possible association of these mortalities with pathogens showed characteristics similar to those found in the Portuguese oyster *Crassostrea angulata* and the Japanese oyster *Crassostrea gigas* infected by an iridoviridae-like virus. This infection was named gill necroses virus infection (GNV). In a recent study using a transmission electron microscope (TEM) we could not find any virus in adult oysters with clinical and histological symptoms similar to those described for GNV. However, new TEM images showed the presence of viral particles in eroded gills of oysters. Morphological characteristics, such as thin-walled, icosahedric shape, the presence of capsids in an extension of the nucleus or in a vacuole and size varying from 80 to 90 nm suggest that the viruses belong to the Herpesviridae. This virus could be involved in the mortality episodes in the bay and it is different from those described as the causal agent of GNV.

Virus tipo Herpes asociado con la erosión branquial en adultos del ostión Japonés *Crassostrea gigas* en México

Durante 1997, se presentaron mortalidades inusuales en el cultivo de ostión en Bahía Falsa, Baja California, México. Estudios sobre la posible asocación de estas mortalidades con patógenos mostró características similares a las encontradas en el ostión Portugués *Crassostrea angulata* y el ostión Japonés *Crassostrea gigas* infectado por un iridovirus hacia finales de los años 60's. A esta infección se le nombró Virus de la Necrosis Branquial (GNV, por sus siglas en inglés). En estudios recientes en ostiones adultos con síntomas clínicos e histológicos similares a los descritos a la GNV, y utilizando microscopía electrónica de transmisión (MET) no encontramos la presencia del iridovirus. Sin embargo, nuevas imágenes del MET mostraron la presencia de partículas virales en las branquias erosionadas del ostión. Las características morfológicas que incluyen una pared delgada, la forma icosahédrica de la cápside, la presencia de cápsides en una extensión del núcleo o en una vacuola y el tamaño que varía entre 80 a 90 nm sugiere que estos virus están relacionados con la familia Hesperviridae. Estos virus pueden estar asociados a los episodios de mortalidad presentes en la bahía y son diferentes de la descripción del agente causal de la GNV.

Identification isolated bacteria from gills of the Japanese oyster *Crassostrea gigas* cultured in Bahía Falsa, B. C., México during a mortality episode

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Since the late 1970's, the Japanese oyster, *Crassostrea gigas*, has been cultured in Bahía Falsa, Baja California, México. Nowadays, there are 21 companies involved in this activity. In 1997, unusual mortality episodes of oysters began to occur, reaching up to 80% of the production. These mortality episodes have been recurring up to the present, and the hypothesis that a pathogen such as a virus, bacteria or both is involved remains open. This work shows the results of a study on the physiological and biochemical characterization of isolated bacteria from gill tissue of oysters collected during a mortality episode in 2001. Three colonies were isolated. Two of them grew in TCBS selective medium, forming yellow colonies, which were identified as belonging to the genus *Aeromonas*. The third colony could not be cultured or identified. There are no records of the pathogenicity of *Aeromonas* spp. in mollusks; however, they have been reported as pathogenic for fishes and reptiles. Identification of the non-cultivable bacteria must be carried out by molecular methods.

Identificación de bacterias aisladas de las branquias del ostión Japonés *Crassostrea gigas* cultivado en Bahía Falsa, Baja California, México durante un episodio de mortalidad

Desde finales de los años 70's, el ostión Japonés, *Crassostrea gigas*, se ha cultivado en Bahía Falsa, Baja California, México. Actualmente, existen 21 empresas dedicadas a esta actividad.

Durante 1997, se presentaron mortalidades inusuales en los cultivos de ostión, que alcanzaron más del 80% de pérdida en la producción. Estos episodios de mortalidad siguen siendo recurrentes hasta la fecha y la hipótesis de que algún posible patógeno esté involucrado, ya sea un virus, una bacteria o ambos, permanece vigente. En el presente trabajo se muestran los resultados de un estudio de caracterización fisiológica y bioquímica de bacterias aisladas de tejido branquial de ostiones recolectados durante un episodio de mortalidad en 2001. Se aislaron tres colonias. Dos de ellas crecieron en TCBS, formando colonias amarillas y que fueron identificadas como bacterias del género *Aeromonas*. La tercera colonia no pudo ser identificada. Las bacterias identificadas del género Aeromonas no se describen como patógenos en ostión, aunque sí son patógenos de peces y reptiles. La identificación de esta bacteria no cultivable por métodos convencionales debe llevarse a cabo por métodos moleculares.

VI. POSTER SESSION
SESIÓN CARTELES

Organized by/ Organizado por
Beatriz Cordero Esquivel
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Parasitic diagnosis of the eastern oyster *Crassostrea virginica* of Gulf of Mexico

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The oyster *Crassostrea virginica* is an important resource in the Gulf of México. This resource generates between 80—90 % of the national production of oysters. The purpose of this work was to determine the pathogenic agents that affect natural banks of oyster in the Gulf of México, which have been overharvested in the last years. Sampling was performed in 10 coastal lagoons of the states of Veracruz, Tabasco and Campeche in dry and rainy seasons. Between 60 and 100 oysters were collected in each locality and were transported alive to the laboratory. Thirty oysters were examined for parasites while fresh (including the thioglycollate medium diagnosis of *Perkinsus marinus*), another 30 oysters were fixed and prepared for histological analysis, and between 10 and 15 oysters were used for microbiological diagnosis. With the exception of bacteria, the prevalence, mean intensity and abundance were calculated for each parasitic species per sample. Thirty-five species of bacteria were found, the most frequent belonging to the genera *Pseudomona*, *Aeromona* and *Vibrio*. Two protozoa (*Perkinsus marinus* and *Nematopsis* sp.) and three helminthes (*Urastoma cyprinae*, *Proctoeces maculatus* and *Tylocephalum* sp.) were also found. Prevalence and abundance values were highly variable among localities and among seasons, but usually low in most species. However, the highest prevalence was found in lagoons of the state of Tabasco. All the identified helminthes and protozoa were widely distributed in the Gulf of México, and all of them are usually found in

oysters. Only *Perkinsus marinus* and *Bucephalus* sp. were associated with tissue damage to the hosts. *Perkinsus marinus* was considered the parasite with highest risk for the oyster banks due to their grade of pathogenicity and high prevalence (> 50% in most localities).

Diagnóstico parasitológico del ostión *Crassostrea virginica* del Golfo de México

El ostión *Crassostrea virginica* es un recurso pesquero muy importante en el Golfo de México y genera entre el 80 al 90% de la producción ostrícola nacional. Con el fin de determinar la importancia de los agentes patógenos que afectan los bancos naturales y explotados de ostión en el Golfo de México, se realizaron muestreos en 10 lagunas costeras en época de secas y lluvias abarcando los estados de Veracruz, Tabasco y Campeche. Entre 60 y 100 ostiones fueron colectados en cada localidad y transportados vivos al laboratorio, donde 30 ostiones se procesaron para el diagnóstico de parásitos en fresco, incluyendo el diagnóstico de *Perkinsus marinus* en medio de tioglicolato; 30 se fijaron y procesaron para realizar cortes histológicos y, entre 10 y 15 se utilizaron para el diagnóstico microbiológico. Con excepción de las bacterias, se calculó la prevalencia, intensidad media y abundancia media para cada especie de parásito por muestreo. El estudio reveló la presencia de un total de 35 especies de bacterias entre las que se encontraron más frecuentemente especies de los géneros *Pseudomona*, *Aeromona* y *Vibrio*; 2 protozoarios (*Perkinsus marinus* y *Nematopsis* sp.) y 3 helmintos (*Urastoma cyprinae*, *Proctoeces maculatus* y *Tylocephalum* sp.). Los valores de prevalencia y abundancia fueron muy variables de localidad en localidad y entre épocas, pero generalmente bajos en la mayoría de las especies. Sin embargo, los parásitos mostraron prevalencias más altas en las lagunas de Tabasco. Todos los helmintos y protozoarios identificados están ampliamente distribuidos en el Golfo de México y son parásitos comunes del ostión. Sólo dos especies, *Perkinsus marinus* y *Bucephalus* sp. estuvieron asociadas a daños en los tejidos de sus hospederos. Por su grado de patogenicidad y los altos valores de prevalencia (más del 50% en la mayoría de las localidades) *Perkinsus marinus* se considera el parásito de mayor riesgo para los bancos estudiados.

Genetic analysis of populations of the abalone (*Haliotis* spp.) using RAPD's

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The analysis of randomly amplified polymorphic DNA was applied to four Mexican species of abalone: *Haliotis corrugata*, *Haliotis cracherodii*, *Haliotis fulgens* and *Haliotis rufescens* and two Australian species *Haliotis laevigata* and *Haliotis rubra* using five commercial primers. We present the genetic relationships among Mexican and Australian abalone species in relation to allele frequencies, polymorphism, heterozygosity and genetic distances. Ninety-two polymorphic loci were found. The degree of polymorphism (95% criterion) was from 17% to 45%, and the heterozygosity was from 0.06 to 0.14. Genetic distances were between 0.03 and 0.97, but there was not a correspondence between the genetic and the geographical distance.

Análisis genético de poblaciones de abulón (*Haliotis* spp.) mediante el uso de RAPD's

Se realizó un análisis de ADN polimórfico amplificado al azar a cuatro especies de abulones mexicanos: *Haliotis corrugata*, *Haliotis cracherodii*, *Haliotis fulgens* y *Haliotis rufescens* y dos especies australianas *Haliotis laevigata* y *Haliotis rubra* utilizando 5 iniciadores comerciales. En este trabajo presentamos las relaciones genéticas entre especies de abulones mexicanos y australianos con relación a las frecuencias alélicas, polimorfismo, heterocigocidad y distancia genética. Se encontraron 92 loci polimórficos. El grado de polimorfismo (criterio al 95%) fue de 17% a 45%, y la heterocigocidad fue de 0.06 a 0.14. La distancia genética fue de entre 0.03 y 0.97, pero no hubo correspondencia entre la distancia genética y geográfica. En este trabajo se discute al respecto.

Preliminary results in reproductive effort of *Atrina maura* in Laguna de San Ignacio BCS, México

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The fishery for the pen shell (¨Callo de Hacha¨), *Atrina maura*, along the peninsula of Baja California has increased in recent years. Studies on the development of this fishery are important to build future management plans. Pen shells are harvested in five zones of the peninsula, of which Laguna de San Ignacio (LSI), Baja California Sur, is one of the most important. Although there are many available qualitative studies describing the reproductive cycle in bivalve mollusks, there are few quantitative studies. This work addresses that issue. Starting in March 2002, seven individuals were sampled monthly in LSI. Height and length, total weight, shell weight, adductor muscle weight, and body weight were recorded. The total body volume and the volume of the valve cavity were also determined. The volumetric condition (IC) and muscle yield (IRM) indices were calculated. Transverse gonadal sections were made for standard histological analysis. The tissue slides were stained with hematoxilin—eosine, and photographed for analysis with Sigma Scan® software. Measurements and content analysis were used to determine ovocyte maturity. The lipids, carbohydrates and proteins in the gonad, digestive gland and muscle were analyzed to determine their relation with the gonadal cycle, which results are presented in this work

Resultados preeliminares sobre el esfuerzo reproductivo de *Atrina maura* en Laguna de San Ignacio Baja California Sur, México

La pesquería del Callo de Hacha, *Atrina maura* en la Península de Baja California ha aumentado en los últimos años. Por este motivo, los estudios sobre el desarrollo de dicha pesquería son importantes para establecer futuros planes de manejo. La captura de Callo de Hacha se realiza en 5 zonas de Baja California, entre ellas, la Laguna de San Ignacio, Baja California Sur es una de las más importantes. Existen diversos estudios que describen

cualitativamente el ciclo reproductivo de moluscos bivalvos; sin embargo, hay pocos trabajos cuantitativos sobre el esfuerzo reproductivo. En este trabajo se presentan algunos resultados sobre la biología reproductiva de *A. maura* que brindan mayor información cuantitativa y cualitativa al respecto. Durante el año 2002, se recolectaron mensualmente 7 ejemplares en la laguna de San Ignacio. Se registraron los siguientes datos morfométricos: altura y longitud total, peso total, peso de la concha, peso del músculo abductor y peso del cuerpo. También se determinó el volumen total del cuerpo y el volumen de la cavidad intervalvar. Se calcularon tanto el índice de condición (IC) como el rendimiento del músculo (IRM). Se realizaron cortes transversales de la gónada para su análisis histológico convencional. La tinción usada fue hematoxilina-eosina y el tejido fue fotografiado para su análisis con el software de Sigma Scan®. Se realizaron las mediciones y conteos pertinentes de ovocitos para determinar su madurez. Se realizaron análisis de lípidos, carbohidratos y proteínas de la gónada, glándula digestiva y músculo para determinar su relación con el ciclo gonadal. Los resultados de dichos análisis se presentan en este trabajo.

Histopathological analysis of the native oyster *Ostrea conchaphila* (= *O. lurida*) in relation to mortality episodes of Japanese oyster *Crassostrea gigas* from Bahia Falsa, Baja California, México

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The native oyster *Ostrea conchaphila* is found naturally in Bahía Falsa, Baja California, where the Japanese oyster *Crassostrea gigas* was introduced in the middle seventies for culture. Since 1996, unusual mortalities of Japanese oysters have been occurring. One of the hypotheses to explain these mortalities is the presence of eroded gills and a pathogen, particularly a herpes-like virus recorded in the branchial tissue of some Japanese oysters. The question whether these erosions or virus are present in the native oyster is relevant to explain a possible transmission from one species to the other. A retrospective histopathological analysis of paraffin embebed samples of *O. conchaphila* taken between May 1996 and April 1997, when unusual mortalities of the Japanese oyster occurred, was carried out using routine histological procedures. Tissues were stained with hematoxilin and eosin-floxin and were observed using a transmitted light microscope. The results showed the presence of a *Ancistrocoma*-like ciliated protozoan in a prevalence of 42.8% and mean intensity of 5.9 protozoa per infested oyster. In one organism a cyst of a metazoan was found in mantle and in two organisms, we detected hemocyte infiltration in tissue surrounding the digestive diverticuli, the epithelia of which were damaged. No evidences of gill erosion or viral inclusions in gills were found. The *Ancistrocoma*-like protozoan was also found in the Japanese oyster sampled in 1996-1997, but it has not been related to mortality episodes anywhere. The absence of eroded gills and viral particles suggests that, if the hypothesis of a viral infection as cause of mortalities of *C. gigas* in Bahía Falsa is corroborated, the virus does not affect the native oyster.

Análisis histopatológico del ostión nativo *Ostrea conchaphila* (=*O. lurida*) en relación con los episodios de mortalidad del ostión Japonés *Crassostrea gigas* de Bahía Falsa, Baja California, México

El ostión nativo *Ostrea conchaphila* se encuentra naturalmente en Bahía Falsa, Baja California en donde se introdujo el ostión Japonés *Crassostrea gigas* para cultivo a mediados de los años 70. Desde 1996, se han presentado recurrentemente episodios inusuales de mortalidad del ostión Japonés en la Bahía. Una de las hipótesis para explicar dichas mortalidades es la presencia de branquias erosionadas asociadas a un herpesvirus encontrado en el tejido branquial de algunos ostiones de la zona. La pregunta de si o no esas erosiones y/o virus se presentan en el ostión nativo, es importante para explicar un posible efecto de la transfaunación de especies. Para responder a dicha pregunta, se realizó un análisis histopatológico retrospectivo de muestras embebidas en parafina de *O. conchaphila* obtenidas entre mayo de 1996 y abril de 1997, cuando ocurrieron las primeras mortalidades masivas del ostión Japonés en la Bahía. Para tal efecto se realizaron los procedimientos histológicos de rutina. Los tejidos se tiñeron con hematoxilina y eosina-floxina y se observaron usando un microscopio de luz transmitida. Los resultados mostraron la presencia del protozoo ciliado tipo-*Ancistrocoma* con una prevalencia del 42.8% y una intensidad media de 5.9 ciliados por ostión. En un organismo se encontró un quiste de un metazoo en tejido del manto y en dos organismos se observaron hemocitos infiltrando los tejidos que rodean a los divertículos digestivos, cuyos epitelios se observaron deformados. No se encontraron evidencias de erosión branquial o inclusiones virales en las branquias del ostión nativo. El protozoo tipo *Ancistrocoma*, también se encontró en el ostión Japonés muestreado entre 1996 y 1997, pero, este organismo no se ha asociado con episodios de mortalidades masivas de ostión en ninguna localidad. La ausencia de branquias erosionadas y partículas virales sugiere que si se confirma la hipótesis de que una infección viral es la causa de las mortalidades masivas del ostión Japonés, este virus no se encuentra en el ostión nativo.

Parasitological and histopathological analysis of the ribbed mussel *Geukensia* (=*Ischadium*) *demissa*, from Estero de Punta Banda, Baja California, México

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The ribbed horse mussel *Geukensia demissa* was accidentally introduced into San Francisco Bay before 1890 and has spread along the California shore. A population of this species is now well established in the Estero de Punta Banda Baja California, México. The origin of this species in the study area is unknown; presumably, it was introduced from California. Currently this

species is locally harvested for human consumption. There is not any information on the sanitary condition of this exotic mussel. The aim of this study was to carry out a survey of the parasitological load and histopathological condition of the species in the inner, middle and outer areas of the Estero. Mussels were analyzed fresh to determine presence of symbionts and the condition of the shell. Histopathological analysis of paraffin embedded samples was carried out using routine histological procedures. Tissues were stained with hematoxilin and eosin-floxin and observed using a transmitted light microscope. The parasitic copepod *Pseudomyicola spinosus* and an unidentified calanoid copepod were recorded crawling on the mantle, gills and labial palps of the host. Epibionts like *Balanus* sp. on the shell and some nematodes in the pallial fluid were recorded. At the histological level, different grades of hemocityc infiltration were found in the connective tissue of the mantle, gonads and digestive diverticuli, stomach and intestine. One cyst of an unidentified metazoan was found inside a reproductive follicle. *Pseudomyicola spinosus* was found occluding the lumina of the intestine. Differences in symbionts, parasites and tissue alterations are discussed in relation to the different ecological conditions in the sampled localities of the Estero de Punta Banda and parasites of bivalve mollusks previously recorded in the area.

Análisis parasitológico e histopatológico del mejillón *Geukensia* (= *Ischadium*) *demissa*, del Estero de Punta Banda, Baja California, México

El mejillón *Geukensia demissa* fue introducido accidentalmente en la Bahía de San Francisco hacia 1890 y de ahí, se distribuyó a lo largo de la costa de California. Una población de esta especie se ha establecido en el Estero de Punta Banda Baja California, México. Se desconoce el origen de esta especie en dicho estero; probablemente, fue introducida desde California. Actualmente esta especie se recolecta localmente para consumo humano. No existe información sobre el estado sanitario de este mejillón exótico. El objetivo de este estudio fue llevar a cabo un análisis de la carga parasitaria y la condición histopatológica de la especie en tres puntos del Estero de Punta Banda: zona externa, media e interior. Los mejillones se analizaron en fresco para determinar la condición de la concha y simbiontes. El análisis histopatológico de los tejidos embebidos en parafina se realizó siguiendo la rutina histológica. Los tejidos se tiñeron con hematoxilina y eosina-floxina y se observaron bajo el microscopio de luz transmitida. En el manto, branquias y palpos labiales se encontraron reptando, al copépodo parásito *Pseudomyicola spinosus* y a un copépodo calanoide. Sobre la concha se encontraron algunos balanos y nemátodos en el fluido intervalvar. A nivel histopatológico se encontraron diferentes grados de infiltración hemocitaria en tejido conectivo de los divertículos digestivos, intestino, estómago y gónada. Se encontró un quiste de un metazoo dentro de un folículo reproductivo. El copépodo *Pseudomyicola spinosus* se encontró obstruyendo el lumen del intestino y estómago, causando erosión de los epitelios de dichos órganos. Se discute sobre los simbiontes, parásitos y alteraciones histológicas encontradas en relación con las condiciones ambientales de los puntos estudiados dentro del Estero. También se analiza su relación con los registros de carga parasitaria de los moluscos de la zona.

Terrestrial gastropods of south Nuevo Leon, México

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Forty-three genera, 81 species and 14 subspecies of terrestrial gastropods belonging to 23 families are recorded for the southern area of the state of Nuevo Leon. Eighteen species and one subspecies are new records for the state. The families with with the highest number of species are: Spiraxidae (16), Urocoptidae (9), Pupillidae (8), Helicinidae (7) and Zonitidae (6). The species with the highest distribution per locality are: *Gastrocopta pellucida* (16), *Pupisoma dioscoricola insigne* (13), *Punctum vitreum*, *Mesomphix montereyensis victoriana* and *Thysanophora hornii* (11) and *Guppya gundlachi* (9). Seventy-four species (91.3%) of the terrestrial malacofauna are pulmonata and only 8.7% (7 species) are prosobranchia. From the area of study, only 34 (42%) are micro mollusks. This is the highest number found for any region in northeast Mexico. *Gastrocopta ashmuni* was recorded for the first time for this region. Considering the records from the north of the state of Nuevo Leon, 86 species are known for the state.

Gastrópodos terrestres del sur de Nuevo León, México

Cuarenta y tres géneros, 81 especies y 14 subespecies de gasterópodos terrestres pertenecientes a 23 familias se registran para la región sur del estado de Nuevo León. Dieciocho especies y una subespecie son nuevos registros. Las familias con más especies son Spiraxidae (16), Urocoptidae (9), Pupillidae (8), Helicinidae (7) y Zonitidae (6). Las especies con mayor distribución por localidades son *Gastrocopta pellucida* (16), *Pupisoma dioscoricola insigne* (13), *Punctum vitreum*, *Mesomphix montereyensis victoriana* y *Thysanophora hornii* (11) y *Guppya gundlachi* (9). El 91.3% (74 especies) de la malacofauna terrestre es pulmonada y sólo el 8.7% (7 especies) son prosobranquias. Del total de especies en el área de estudio 34 (42%) son micro moluscos. Este es el valor más alto hallado para alguna región en el noreste de México. Se indica a *Gastrocopta ashmuni* por primera vez para esta zona de la República Mexicana. Tomando en cuenta los registros del norte del estado se conocen en total 86 especies para Nuevo León.

Distribution of "G" bands in the karyotype of *Pomacea patula catemacensis*

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The G bands in the karyotype of *Pomacea patula catemacensis* were studied and routine techniques were used to obtain trypsin-giemsa banding patterns in mitotic chromosomes of gonadal tissue cell. The results of this study may be useful in future research related to the

cytogenetics and cytotaxonomy of these freshwater snails, due to the agreement of the diploid number and gross morphology in the cytogenetics of the genus *Pomacea*.

Distribución de bandas "G" en el cariotipo de *Pomacea patula catemacensis*

Se estudiaron las Bandas "G" en el cariotipo de *Pomacea patula catemacensis*. Se utilizaron técnicas de rutina para obtener patrones de bandeo (tripsina-giemsa) en cromosomas mitóticos de células del tejido gonadal. Los resultados de este estudio pueden ser utilizados para futuras investigaciones relacionadas con la cito- taxonomía y/o sistemática debido al arreglo del número cromosómico diploide y morfología en la citogenética del género *Pomacea*.

Molecular characterization of *Vibrio harveyi* and its pathogenicity to postlarval *Mytilus californianus*

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A limiting factor for sustainable development of aquaculture is the presence of bacterial diseases in farmed organisms worldwide. Many members of the genus *Vibrio* have been implicated in these diseases, principally because these microorganisms are not only ubiquitous in the marine environment but they are also considered the principal bacterial group that form part of the normal flora of healthy marine organisms. Over the past decade, strains of *Vibrio harveyi*, have been recognized as significant pathogenic agents and a cause of high rates of mortality in many commercially cultured invertebrate species, such as oysters, shrimps and clams, principally in larval stages. Among the technologies used for diagnosis of *V. harveyi* in farms are biochemical tests and ELISA. While these methodologies are very useful, the techniques are time-consuming and can generate false-positive results. The development and sustainability of aquaculture urgently requires the rapid species-specific identification of *V. harveyi* for its effective control. Likewise, it is necessary to rely on technologies that would allow us to distinguish between virulent and avirulent strains of the bacterium. This study evaluated susceptibility of *Mytilus californianus* postlarvae to *V. harveyi*. Static bioassays in plastic container were carried out using concentration of 3.6 X 105 cfu ml-1. Postlarval survival was evaluated after 48 h. Also, we designed oligonucleotides targeting the genes txR, vhh-1, vhhB, luxL, luxM, luxN and developed a PCR methodology for the species-specific identification of *V. harveyi*. We also used the random amplified polymorphic DNA (RAPD) technique to characterize genetic differences between strains of *V. harveyi* and *Vibrio* spp. Preliminary results showed that postlarval *Mytilus californianus* were susceptible to *V. harveyi*. Mortalities of 80% were observed. Higher sizes of postlarvae seem to have less susceptibility to this bacterium. Primers for txR, vhh1, vhhB, LuxL and luxM were not specific for *V. harveyi* identification due to the amplification of genes of other *Vibrio* species. With regard to luxN primers, one product of the expected size (2048 bp) was amplified in the control strain, but not by the other *Vibrio* species and non-*Vibrio* spp. assessed. In addition, fifteen environmental isolates of *Vibrio* spp.

were tested and eight isolates had an amplified product of the same size. The RAPD analysis using OPS11 primer, gave similar patterns between environmental isolates identified as *V. harveyi* and the control strain. This primer also discriminated between pathogenic and nonpathogenic strains of *V. harveyi* and allowed us to differentiate various *Vibrio* species. Our results indicated that *V. harveyi* is pathogenic for postlarval mussels. The PCR and RAPD-based methodologies allowed a rapid and accurate diagnostic assay for this bacterium, and thus it may be a helpful tool in the identification and differentiation of *V. harveyi* strains.

Caracterización molecular de *Vibrio harveyi* y su patogenicidad hacia larvas de *Mytilus californianus*

A nivel mundial, uno de los principales factores que limitan el desarrollo de la acuacultura, es la presencia de enfermedades bacterianas en organismos marinos cultivados. Diferentes especies del género *Vibrio* han sido implicadas en estas enfermedades, principalmente debido a que estos microorganismos no son ubicuos solamente en el ambiente marino, sino que también son considerados como el principal grupo bacteriano que forma parte de la flora normal de organismos marinos saludables. Diferentes cepas de *Vibrio harveyi*, han sido reconocidas como patógenas y como causa de tasas altas de mortalidad en muchas especies de invertebrados cultivados, tales como ostiones, camarones y almejas, principalmente en sus estadios larvales. Entre las tecnologías utilizadas para la identificación de *V. harveyi* en granjas de producción acuícola, se encuentran las pruebas bioquímicas y el ELISA. Sin embargo, aún y cuando estas metodologías son muy útiles, requieren tiempos prolongados para su realización, además de que pueden generar resultados falsos-positivos. El desarrollo y la sustentabilidad de la acuacultura requiere de una identificación rápida de *V. harveyi*, para su control efectivo. Asimismo, es necesario utilizar tecnologías que nos permitan distinguir entre cepas virulentas y no virulentas de esta bacteria. Este estudio evaluó la susceptibilidad de postlarvas de *Mytilus californianus* (1-4 mm) hacia *V. harveyi*. Se realizaron bioensayos en contenedores plásticos, utilizando una concentración de 3.6 X 10^5 ufc ml^{-1}. Se evaluó la sobrevivencia de las postlarvas a las 48 h. Por otra parte, diseñamos oligonucleótidos dirigidos a los genes *txR*, *vhh-1*, *vhhB*, *luxL*, *luxM*, *luxN* y desarrollamos una metodología de PCR para la identificación especie-específica de *V. harveyi*. También, se utilizó la técnica del ADN Polimórfico Amplificado al Azar (RAPD) para caracterizar las diferencias genéticas entre las cepas de *V. harveyi* y *Vibrio* spp. Resultados preliminares mostraron que postlarvas de *M. californianus* fueron susceptibles a *V. harveyi*, observándose mortalidades del 80%. Las postlarvas de mayor tamaño (3-4 mm) mostraron una menor susceptibilidad hacia esta bacteria. Los primers para *txR*, *vhh-1*, *vhhB*, *LuxL* y *luxM* no fueron específicos para la identificación de *V. harveyi*, debido a la amplificación de genes de otras especies de *Vibrio*. Con respecto a los primers *luxN*, un producto del tamaño esperado (2,048 pb) fue amplificado por la cepa control, no así en otras especies de *Vibrio*, ni en los otros géneros bacterianos evaluados. Además, 15 aislados ambientales de *Vibrio* spp. fueron evaluados y ocho de éstos mostraron un producto amplificado del mismo tamaño. El análisis RAPD, utilizando el oligonucleótido OPS-11 mostró patrones similares entre los aislados ambientales identificados

como *V. harveyi* y la cepa control. Este oligonucleótido también discriminó entre cepas patógenas y no patógenas de *V. harveyi*, permitiendo diferenciar varias especies de *Vibrio*. Los resultados indican que *V. harveyi* es patógeno para postlarvas de *M. californianus*. Las metodologías basadas en el PCR y RAPD, permitieron un diagnóstico rápido y preciso de esta bacteria, por lo que estas técnicas constituyen una herramienta útil para la identificación y diferenciación de cepas de *V. harveyi*.

Allometric analysis of juveniles of the red abalone, *Haliotis rufescens*, in a recirculating aquaculture system

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Recirculating aquaculture systems have started to be used in abalone culture. Alkalinity is one of the most important environmental variables to be considered. Nitrifying bacteria need bicarbonate and carbonate ions as a carbon source. Thus, nitrification reduces the amount of alkalinity in the recirculating system and reduces the buffering capacity of the seawater. Reduction in alkalinity can cause a drop in pH, and abalone shell may be dissolved to compensate carbonate consumption. In this work, we present an allometric analysis to compare the sizes of juvenile red abalone between a recirculating and a flow through culture systems as an evaluation of shell dilution due to pH reduction.

Análisis alométrico de juveniles de abulón, *Haliotis rufescens*, en un sistema de recirculación

Los sistemas de recirculación en acuacultura se han empezado a utilizar para el cultivo de abulón. La alcalinidad es una de las variables ambientales más importantes ha considerar. Las bacterias nitrificantes requieren de iones carbonato y bicarbonato como fuente de carbono. De esta manera, la nitrificación reduce la alcalinidad en los sistemas de recirculación, así como reduce la capacidad de amortiguamiento del sistema. La reducción de alcalininidad puede causar la caída en el pH, y las conchas de abulón pueden comenzar a disolverse para compensar el consumo de carbonatos. En este trabajo presentamos un análisis alométrico para comparar las tallas de juveniles de abulón rojo entre un sistema de recirculación y uno de flujo abierto como una evaluación de la disolución de la concha debido a la reducción del pH.

Molluscs in coastal lagoons of Sonora and Sinaloa, Mexico: Habitat and habits

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Studies carried out in lagoon systems of the Mexican Pacific have provided data on species richness, feeding types and the sedimentary environment of benthic mollusks. These lagoons are Guaymas and Yavaros in the state of Sonora; Topolobampo and Caimanero-Huizache in the state of Sinaloa; and Agiabampo on the border between these two states. Sampling took place during the winter (February-March) and summer (August-September) of 1984 in areas that included different environments within each lagoon. Biological samples were collected with an otter trawl, and with a Van Veen grab sampler that obtained constant volumes of 1 liter of damp surface sediment, to insure collection of the highest possible number of species. We identified 265 mollusk species, of which 129 were Bivalvia, 130, Gastropoda and 6 Scaphopoda. Most of the bivalves were shallow infaunal detritivores and filter feeders, the scaphopods were infaunal detritivores, and the gastropods included numerous epifaunal carnivores. In the lagoons of Sonora, where communication with the sea is permanent, salinity is close to seawater and the substrate is predominantly sandy, whereas salinity fluctuates widely and the sediment is mainly silty clay in the lagoons of Sinaloa where seasonal inputs of freshwater are common.

Moluscos de las lagunas costeras de Sonora y Sinaloa, México: Hábitat y hábitos

Los estudios que hemos realizado sobre moluscos bentónicos de sistemas lagunares del Pacífico Mexicano, nos han brindado datos sobre la riqueza de especies, tipos de alimentación y el ambiente sedimentario. Esas lagunas son Guaymas y Yavaros en el Estado de Sonora; Topolobampo y Caimanero-Huizache en el estado de Sinaloa; y Agiabampo en la frontera entre esos dos estados. Los muestreos se realizaron durante el invierno (febrero y marzo) y verano (agosto y septiembre) de 1984 en áreas que incluyeron diferentes ambientes dentro de cada laguna. Las muestras biológicas se recolectaron con una "otter trawl", y con un muestreador Van Veen que obtuvieron volúmenes constantes de 1 litro de sedimento, para asegurar la recolecta del mayor número posible de especies. Se reconocieron 265 especies de moluscos, de los cuales 129 corresponden a la clase Bivalvia, 130 a la clase Gasterópoda y 6 a la clase Escaphopoda. La mayoría de los bivalvos fueron detritívoros y filtroalimentadores, los escaphopodos fueron detritívoros y los gasterópodos incluyeron gran número de especies carnívoras. En las lagunas de Sonora, la comunicación con el mar es permanente, la salinidad es cercana a la marina y el sustrato es predominantemente arenoso, mientras que la salinidad fluctúa ampliamente y el sedimento es principalmente limoso en las lagunas de Sinaloa, donde son comunes los aportes estacionales de agua dulce.

Prevalence of the parasite *Sabinella shaskyi* (Gastropod: Eulimidae), and sublethal damage in *Eucidaris galapagensis* (Echinoidea) in the Galapagos Islands, Ecuador.

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Introduction

In the Galapagos Marine Reserve, Ecuador, the magnitude and severity of fishing pressure on lobsters and fish, and the lag time for these effects is unknown. If lightly-fished sites are compared to heavily fished sites (where urchin and crab predators, such as lobster and fish, are removed), we expect that the heavily fished sites to be more stressed with higher urchin abundance and higher infections by parasites. This hypothesis is strongly supported by the most fundamental principle of epidemiology, which says: parasite transmission strongly interacts with fisheries (Lafferty *et al.* 1999). Anderson and May (1981), reported that the prevalence of infections tends to increase with host population density. The aim of this study is to determine the patterns of prevalence of infection by the eulimid ectoparasitic gastropod *Sabinella shaskyi*, and to quantify the sublethal damage on the most conspicuous sea urchin, *Eucidaris galapagensis* (as host), around the center of the Galapagos archipelago.

Material and Methods

Twenty shallow sheltered rocky reefs sites, 10 lightly fished sites (LFs) and 10 heavy fished sites (HFs) were selected in the central region of the Galapagos Islands. Urchins and snails were measured with a sliding caliper, and urchin density was measured within a 10 m x 2 m belt transects (n = 30 per transect). Prevalence of infection was calculated by the number of urchins infected per number of urchins examined, and the sublethal damage was evaluated considering lesions on their spines. Standard deviations are shown in the graphs.

Results

Urchins and parasites were widely distributed around the center of the Galapagos archipelago. A total of 24,818 urchins were counted and 3,915 parasites, were collected. The highest densities of urchins were found in HFs. In spite of that, there was no significant difference in urchin density between HF vs. LF sites (ANOVA, $p = 0.143$). The maximum number of parasites on the same host was 63 (including both adult and juvenile parasites), and the maximum occurrence on a single spine was seven. The greater concentration of parasites (75%) was in LFs, but no significant difference was found in parasite concentration between HF vs. LF sites (ANOVA, $p = 0.071$). The prevalence of infection varied between 0% and 86%. The LFs showed significantly greater average values of prevalence of infection compared to the HFs (ANOVA, $p < 0.001$) (Fig. 1). Eighty-three percent of the urchins collected showed sublethal

lesions in their spines (galls and scars, associated to processes of erosion and inflammation of epidermis) (Fig. 1).

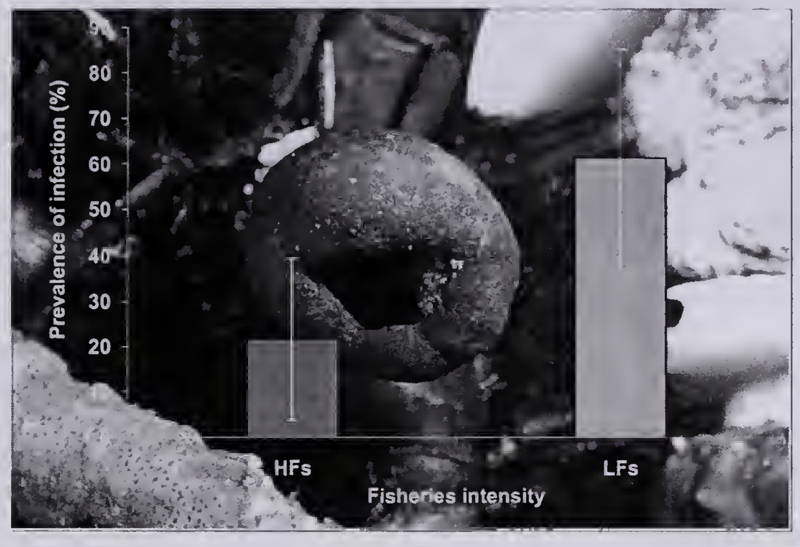

Figure 1. Prevalence of infection and sublethal damage (galls) in the urchin spines from *Eucidaris galapagensis* by the gastropod *Sabinella shaskyi*. The LF sites showed significantly greater average values of prevalence of infection compared to the HF sites in the Galapagos archipelago.

As a regular pattern, parasites preferred to drill new spines. From all sea urchins collected, 42.6% had crabs on their spines. Crab prevalence was significantly greater in HFs (71.67%) versus LFs (15.78%) (ANOVA, $p < 0.001$) (Fig. 2).

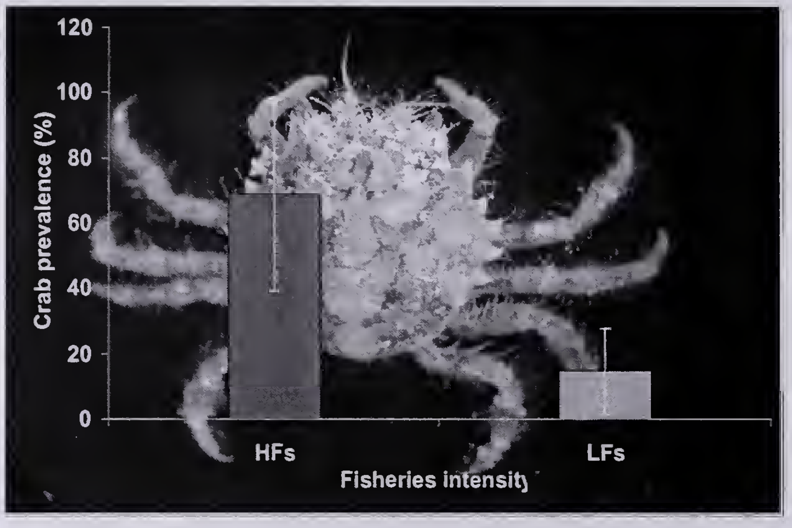

Figure 2. Brachyuran crab prevalence on the urchin spines (*E. galapagensis*). The HF sites showed significantly greater average values of prevalence of infection compared to the LF sites in the Galapagos archipelago.

Discussion

The high occurrence of parasites (*Sabinella*) in LFs was probably associated with a low density of parasite predators (e.g., brachyuran crabs associated to urchins) in LF sites. The results suggest three points: (1) A mediated effect due the high specificity of fisheries around the center of the Galapagos archipelago which causes fishing down marine food webs, that is, the predators of the sea urchins (e.g., lobsters and fish) are fished out, affecting sea urchin densities in HFs (Christensen & Pauly 1998, Pauly *et al.* 1999), (2) there exists a clear pattern in the distribution and abundance of the parasites and their predator, crabs and (3) in HFs, extraction of lobsters and fish (predators of the sea urchins and crabs, respectively), increase the densities of the sea urchins, but indirectly the occurrence of parasites decreases after the removal of the predators of the crab (e.g., fish). Therefore, the densities of the crabs increase and generate control in the number of parasites. Then, in contrast to the original hypothesis mentioned, a new conceptual model must be proposed to explain the biological interactions between fishing, urchin densities, parasites and snail predators (brachyuran crabs).

Prevalencia del parásito *Sabinella sharskyi* (Gasterópodo: Eulimidae), y daño subletal en *Eucidaris galapagensis* (Echinoidea) en las Islas Galápagos, Ecuador

El erizo marino más conspicuo de las Islas Galápagos, *Eucidaris galapagensis* es parasitado por el gasterópodo *Sabinella sharskyi* (Eulimidae). Es la única especie de equinodermo en el

Archipiélago con el cual se asocia *S. sharskyi*. Este estudio fue llevado a cabo seleccionando 20 ambientes rocosos/arenosos de baja energía alrededor de las islas centrales del Archipiélago Galápagos (Ecuador) en noviembre y diciembre de 2003, considerando 10 localidades de pesca intensa (Hf) y 10 de pesca escasa (Lf). Se contó un total de 3,914 caracoles y 24,818 erizos. Ambos se distribuyen ampliamente alrededor de todo el Archipiélago Central. El 85% de los erizos de las localidades Lf estuvieron altamente infestados, mostrando un daño severo (perforados, erosionados y con galerías y cavernas) y espinas inflamadas. Dado que el caracol es un ectoparásito, se alimenta del mucus sobre el epitelio de las espinas del hospedero. La infestación varió entre 0% y 90%, y el número máximo de parásitos encontrados en un hospedero fue de 51 (adultos y nuevos reclutas) y 7 caracoles en la misma espina. Entre el 25% y 42% de las espinas del hospedero pueden estar dañadas por los parásitos. Depredadores y parásitos interactúan como parte de los componentes del ecosistema, entonces definen el patrón de ocurrencia de *Sabinella*. Las altas densidades de predadores de los parásitos (i.e., cangrejos) encontrados en las localidades Hf, y la densidad de *E. galapagensis* en las localidades Hf y Lf, podrian indicar que la pesca local artesanal en las Islas Galápagos (i.e., langostas y peces como predadores de erizos marinos) indirectamente favorecen las condiciones para los caracoles parásitos.

Thermoregulatory study in pink abalone *Haliotis corrugata*

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A physiological study of juvenile pink abalone *Haliotis corrugata* was done. The organisms used for experimentation were 25.7 ± 1.3 mm length and 18.5 ± 0.9 mm wide, and weighted 2.0 ± 0.35 g. Preferred temperature was obtained by putting the organisms in two different salinities (25‰ and 35‰) using the gravitational method. The experiment was carried out in a horizontal thermal gradient divided in 15 segments with temperatures between 10.05 ± 0.58ºC and 32.53 ± 1.04ºC, constant aeration, and water flow rate between 130 and 150 ml/min. The preferred temperature was 25.0 ± 0.71 ºC. No significant differences were found among the preferred temperatures by the juveniles acclimated in the salinities of 25‰ and 35‰. The equation of Jobling (1981) was used to calculate the optimum temperature for growth, which was 24.5 ºC. During the first hour of experimentation, the displacement velocity of the organisms acclimated in the two salinities had an interval from 48.89 to 50.9 cm/h. They displaced at 13 cm/hr during the day light phase. The velocity diminished (18.3 - 20 cm/hr) once the organisms were located around the preferred temperature. During the night phase, the displacement velocity was 10.1 cm/hr. These velocities were not significantly different ($P>0.05$). The maximum critical temperature (TCMax) was calculated according the methodology described by Díaz *et al.* (2000), which was 32ºC at 50%.

Estudio de termoregulación en abulón rosa *Haliotis corrugata*

Se realizó un estudio sobre termoregulación en juveniles de abulón rosa. Los organismos utilizados en el estudio midieron 25.7 ± 1.3 mm de longitud y 18.5 ± 0.9 mm de ancho, y pesaron 2.0 ± 0.35 g. La temperatura preferencial se obtuvo colocando a los organismos a dos salinidades (25‰ y 35‰) utilizando el método gravimétrico. El experimento se realizó en un gradiente térmico horizontal dividido en 15 segmentos con temperaturas entre 10.05 ± 0.58ºC y 32.53 ± 1.04ºC, aereación constante, y flujo de agua entre 130 y 150 ml/min. La temperatura preferida fue de 25.0 ± 0.71 ºC. No se encontraron diferencias significativas de las temperaturas preferidas entre los juveniles mantenidos a las salinidades de 25‰ y 35‰. Se utilizó la ecuación de Jobling (1981) para calcular la temperatura óptima de desarrollo, la cual fue de 24.5 ºC. Durante la primera hora de experimentación, la velocidad de desplazamiento de los abulones aclimatados a las dos salinidades tuvo un intervalo de 48.89 a 50.9 cm/h. Durante la fase diurna, los organismos se desplazaron a una velocidad de 13 cm/h. La velocidad disminuyó (18.3 - 20 cm/h) una vez que los abulones llegaron alrededor de la temperatura preferida. Durante la fase nocturna, la velocidad de desplazamiento fue de 10.1 cm/h. Esas velocidades no fueron significativamente diferentes ($P>0.05$). La temperatura crítica máxima (TCMax) fue calculada de acuerdo con la metodología descrita por Díaz *et al.* (2000), la cual fue de 32ºC al 50%.

Community variations and growth of mollusks in modern carbonate environments along a latitudinal transect in the Gulf of California, Mexico

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The Gulf of California displays a variety of transitional non-tropical carbonate environments in which mollusks are dominant producers. To gain a better understanding of the factors governing the formation and accumulation of these types of carbonates we are: 1) undertaking an analysis of the composition and structure of the benthic mollusks community, 2) determining the annual growth rates of dominant species, and 3) measuring time-series of environmental parameters in situ. Four localities were selected along a north-south transect from temperate to subtropical area, specifically, Bahía de los Ángeles, Punta Chivato, Isla San José, and Cabo Pulmo. Preliminary results indicate that in the southern Gulf of California, Cabo Pulmo, macro mollusks are poorly represented. In San José, highest diversity of bivalve mollusks was found and contained the most important species: *Megapitaria squalida, Glicymeris gigantea, Megapitaria aurantiaca* and *Dosinia ponderosa*. In Punta Chivato, the species *Chione californiensis* was the most abundant and in Bahía de los Ángeles, the scallop *Euvola vogdesi* dominated the community. Individual *E. vogdsei* 19.8 mm in size were collected in Bahía Juncalito Baja California Sur and transported to a culture area (extensive system). The organisms were cultured for 12 months and measurements were taken to determine the growth rate. We found a fast growth (mean shell height of 46.9 mm) through the summer and autumn. In

winter, the mean shell height reached 52.4 mm and shell weight was 41.4 g with a steady growth to summer.

Variaciones de la comunidad y desarrollo de moluscos en ambientes modernos de carbonato a lo largo de un transecto latitudinal en el Golfo de California, México

El Golfo de California muestra una variedad de ambientes transicionales de carbonato no tropical en los cuales los moluscos son productores dominantes. Para entender mejor a los factores que gobiernan la formación y acumulación de esos tipos de carbonato tenemos: 1) garantizar un análisis de la composición y estructura de la comunidad de moluscos bentónicos, 2) determinar las tasas de desarrollo anual de las especies dominantes y 3) medir las series de tiempo de parámetros ambientales *in situ*. Se seleccionaron 4 localidades a lo largo de un transecto norte-sur desde una zona templada hacia una subtropical, específicamente, Bahía de Los Ángeles, Punta Chivato, Isla San José y Cabo Pulmo. Los resultados preeliminares indican que en el sur del Golfo de California, Cabo Pulmo, los macromoluscos están pobremente representados. En Isla San José, se encontró la mayor diversidad de moluscos y las especies más importantes: *Megapitaria squalida, Glicymeris gigantea, Megapitaria aurantiaca* y *Dosinia ponderosa*. En Punta Chivato, *Chione californiensis* fue la especie más abundante y en Bahía de Los Ángeles, la escalopa *Euvola vogdesi* fue la especie dominante en la comunidad. En Bahía Juncalito, Baja California Sur se recolectaron ejemplares de *E. vogdesi* de 19.8 mm y se transportaron a una área de cultivo (cultivo extensivo). Los organismos se cultivaron por 12 meses y se determinó su tasa de desarrollo. Encontramos el máximo desarrollo (altura media de la concha de 46.9 mm) durante el verano y otoño. En invierno la altura media de la concha alcanzó 52.4 mm y el peso de la concha fue de 41.4 g. Durante el verano su desarrollo fue estable

Mollusk community associated with the coral *Pocillopora* in Tenacatita, Jalisco, Mexico

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To characterize the community of mollusks associated with the coral *Pocillopora*, four sampling surveys were conducted in November 2002, March, July and December 2003 at the shallow seashore of Tenacatita, Jalisco (19º 16’ 45” N – 104º 52’ 20” W). *Pocillopora* coral heads (20-30 cm diameter) were sampled using SCUBA and fixed in 10% formalin. Material

was fragmented and cryptic mollusks were sorted and preserved in 70% propanol. From 27 coral heads 331 specimens representing 36 species (24 gastropods and 12 bivalves) were collected. *Lithophaga aristata* and *Quoyula monodonta* were the most abundant species (90 specimens each). Thirty-eight specimens of *Lithophaga plumula* were found. Two bivalve species had 12 specimens each, and 11 species were represented by a single individual. On average, the mollusks were more abundant in March (18.9 individuals per coral head) and less abundant in December (5.1 individuals per coral head). *Quoyula monodonta* was found in 74% of the coral heads. Ovigerous females of this species were found in November 2002 and in July 2003. *Lithophaga aristata* was found in 55% and *Lithophaga plumula* in 44% of the 27 coral heads. Only one species was found in each of 18 samples. Thus, we could not estimate diversity indices or equitability and dominance indices. The graph of species richness shows that this sampling is reliable since the number of species found, so far, is very close to the maximum number of expected species. A Chi-square test showed that 18 species had an aggregated distribution. In addition, 18 species had a random distribution, but at a very different probability level. A cluster analysis (Bray-Curtis simple link) showed no significant groups among samples from the same survey nnor among samples from different surveys. Many empty shells, remarkably those from the gastropod *Hipponix*, were found in the samples, but it is not possible to know if they died in situ or if they were transported from somewhere else. Hermit crabs were also abundant. Identification of some species is still pending but the mollusk community can be considered fairly well described.

Comunidad de moluscos asociados al coral *Pocillopora* en Tenacatita, Jalisco, México

Para caracterizar a la comunidad de las principales especies de moluscos asociados al coral *Pocillopora*, se realizaron 4 muestreos en noviembre de 2002, marzo, julio y diciembre de 2003 en la costa de Tenacatita, Jalisco (19º 16' 45" N – 104º 52' 20" O). Los corales *Pocillopora* (20-30 cm. diámetro) se muestrearon usando equipo de buceo autónomo y se fijaron en formalina al 10%. Se fragmentó el material para obtener la criptofauna malacológica, misma que se preservó en alcohol al 70%. De los 27 corales recolectados se obtuvieron 331 especímenes de 36 especies diferentes (24 de gasterópodos y 12 especies de bivalvos). *Lithophaga aristata* y *Quoyula monodonta* fueron las especies más abundantes (90 ejemplares de cada una). Se encontraron 38 almejas perforadoras, *Lithophaga plumula*. Se encontraron 12 ejemplares de cada una de 2 especies de bivalvos. Once especies estuvieron representadas por un solo ejemplar. En promedio, los moluscos fueron más abundantes en marzo (18.9 ejemplares por coral) y menos abundantes en diciembre (5.1 ejemplares por coral). En el 74% de los corales se encontró a *Quoyula monodonta*. En noviembre de 2002 y julio de 2003, se encontraron hembras ovígeras de esta especie. Las almejas perforadoras *Lithophaga aristata* y *Lithophaga plumula* se encontraron en un 55% y 44%, respectivamente de los corales estudiados. Los valores obtenidos no permitieron calcular los índices de diversidad y por lo tanto, tampoco la estimación de la equitabilidad e índices de dominancia. En la gráfica de riqueza de especies se confirme que el muestreo fue confiable dado que el número de especies encontradas fue muy cercano al número de especies esperadas. La prueba de Chi-cuadrada demostró que 18 especies tuvieron una distribución de agregación. Además, 18 especies tuvieron una distribución aleatoria a un diferente nivel probabilístico. Un análisis de agrupación (Bray-Curtis de enlace simple) mostró que no hubo diferencias significativas de grupos entre muestras del mismo muestreo y tampoco entre

muestras de muestreos diferentes. También se encontraron muchas conchas vacías, en especial del gasterópodo *Hipponix*; sin embargo, no es posible determinar si murieron *in situ* o si arribaron de algún otro lugar. También se encontraron cangrejos ermitaños. Aunque la identificación de algunas especies aún esta pendiente podemos decir que la comunidad de moluscos ha sido bien descrita.

Use of microsatellite loci to evaluate the genetic variability in cultured juveniles of the Japanese oyster *Crassostrea gigas*

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The Pacific oyster, *Crassostrea gigas*, is one of the most widely cultivated mollusks in the world. The species is native to Japan, selected for its fast growth and its great adaptability to culture. In recent years, summer mortalities have been reported among oysters in San Quintín Bay, Baja California and one of the possible factors involved is a low heterozygosity level (indicated by allozyme loci). The objective of the current study is to use microsattelites to determine if there is a change in the heterozygosity and polymorphism.

Uso de microsatélites para evaluar la variablidad genética de juveniles de ostión Japonés *Crassostrea gigas* de cultivo

El ostión Japonés, *Crassostrea gigas*, es uno de los moluscos más ampliamente cultivados alrededor del mundo. Esta especie es originaria de Japón y se ha seleccionado para cultivo debido a su rápido desarrollo y adaptabilidad. En años recientes, se han reportado episodios de mortalidad durante el verano en la Bahía de San Quintín, Baja California y uno de los posibles factores relacionados con estas mortalidades, es el bajo nivel de heterocigosidad (usando loci de alozimas). El presente estudio tiene como objetivo evaluar si hay algún cambio en la heterocigosidad y polimorfismo, usando microsatélites. Los avances obtenidos en este estudio serán presentados en este evento.

Taxonomic key for the identification of benthic opistobranchs in Mexican reefs

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Only few studies have been published about the bubble shells and snails of the subclass Opistobranchia for Mexico. Isolated studies indicate that these species are found in coral reefs located at the Pacific Ocean, Gulf of Mexico, Yucatan Peninsula and Caribbean. Nevertheless, bibliographical sources that provide information about systematic, species richness and distribution, as well as taxonomic keys for the identification of these mollusks, are needed. From this perspective and as a contribution to the knowledge of the benthic opistobranchs of coral reefs in Mexico, a useful taxonomic key to identify and to make revisions the classification of these species has been produced. The taxonomic key includes the families and generic taxa, a glossary of malacological terms and some data about the biology of these organisms.

Claves taxonómicas para la identificación de opistobranquios en arrecifes Mexicano

Pocos trabajos se han publicado sobre los caracoles burbuja y los moluscos de la subclase Opistobranchia de México. Estudios aislados indican que esas especies se encuentran en los arrecifes de coral del Océano Pacífico, Golfo de México, Península de Yucatán y mar Caribe. Sin embargo, se requieren estudios que brinden información sobre sistemática, riqueza de especies, distribución y también de claves taxonómicas para su identificación. Desde esta perspectiva y como una contribución al conocimiento de los opistobranquios bentónicos de los arrecifes de coral de México, se elaboró una clave taxonómica y un ajuste en la clasificación de dichas especies. La clave taxonómica incluye las familias y taxones genéricos, un glosario de términos malacológicos y algunos datos sobre la biología de dichos organismos.

VII. REPORTS OF SOCIETY BUSINESS

1. Student Grant Committee, 2004

Doug Eernisee, Daniel Geiger, Lindsey Groves (Chair), Sandra Millen, and Peter Roopnarine

Recipients of the 2004 WSM Student Grant Awards:

Claire-Louise Martin, National Marine Science Centre, Coffs Harbour, Australia. "Testing the assumed constraints of a symmetrical mantle cavity on increasing body size in fissurellid gastropods" ($800).

Jann Vendetti, University of California, Museum of Paleontology, Berkeley, CA. "Shell character evolution in the extinct Cenozoic gastropod genus *Bruclarkia*" ($500).

Kenneth Hayes, University of Hawai'i, Manoa, Honolulu, HI. "Systematics, phylogeography, and evolution of South American apple snails (*Pomacea*)" ($300).

Executive Board Meeting, Minutes Annual Business Meeting Minutes, and Treasurer's Report are not available.– The Editor